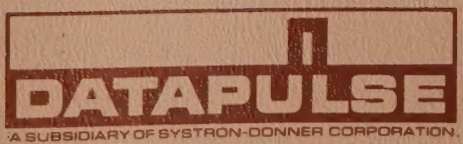
OPERATION & MAINTENANCE

HANDBOOK

MODEL 101

PULSE GENERATOR



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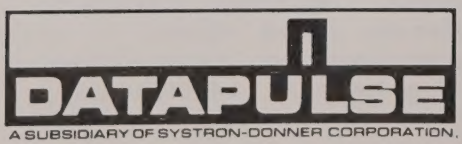

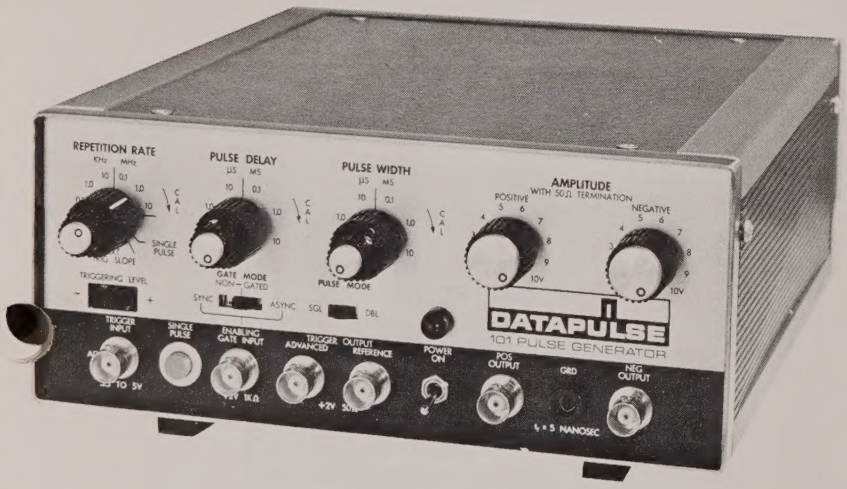

The Datapulse Model 101 is an economical high performance pulse generator designed for a broad range of laboratory test applications. The reduced complexity of its unique solid state circuits combines reliable operation with versatile performance in a conveniently compact package. Its simultaneous positive and negative outputs deliver 2 watts into 50 ohms. Pulse amplitude, width, delay, and repetition rate are continuously variable. Other capabilities include single or double pulse operation, external triggering, synchronous or asynchronous gating, reference trigger outputs, sine wave triggering, and manual single pulse operation.

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LIST OF SCHEMATICS

Drawing Number	Description
J40000-154	Schematic - Model 101
D40000-195	Schematic - Power Supply - Model 101

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SECTION I

SPECIFICATIONS

1.1 Repetition Rate

Repetition rate is continuously variable from 10 hertz to 10 megahertz in six decade ranges for either single or double pulse operation. Effective rates to 20 megahertz may be set up in the double pulse mode.

1.2 External Trigger

The external trigger input is ac coupled. It operates at 0 to 10 megahertz from ±0.25 volt pulses (20 nanosecond minimum duration) or 50 hertz to 10 megahertz from 1 volt rms sine waves. Slope polarity and level controls provide for triggering at any point on the input waveform more than 0.25 volts and less than 5 volts above or below its average dc level. Input impedance is greater than 2.5k ohms. Maximum transient amplitude which may be applied is ±5 volts.

1.3 Manual Cycling

Operation of the SINGLE PULSE pushbutton provides one cycle of output (single or double pulse mode).

1.4 Gated Operation

The mode of operation is selectable as nongated (continuous), synchronously gated, or asynchronously gated output. Signal levels more positive than +1 volt are required for gating. Levels greater than 10 volts may not be applied.

1.4.1 Synchronous Gating

The repetition rate oscillator is disabled in this mode. The gate signal turns the rate oscillator on, synchronizes the first main pulse of the gated bursts with its leading edge, and stops the pulse train with its trailing edge. Both trigger outputs are gated.

1.4.2 Asynchronous Gating

The pulse delay circuit is gated in this mode, and the rate oscillator operates continuously. Main pulse outputs and the reference trigger begin with the first cycle (internally or externally triggered) after the gate pulse occurs and stop when the gate pulse subsides. The advanced trigger is not gated, and occurs at the oscillator repetition rate.

1.5 Trigger Outputs

1.5.1 Advanced Trigger

The advanced trigger is a positive pulse with a minimum amplitude of 1.7 volts from a 50 ohm source, and is typically 15 nanoseconds in duration. It is available on internally triggered operations only. It occurs approximately 10% of the repetition rate period before the reference trigger.

1.5.2 Reference Trigger

The reference trigger is a positive pulse with a minimum amplitude of 2.0 volts from a 50 ohm source, and is typically 15 nanoseconds in duration. It occurs approximately 30 nanoseconds after triggering from an external source.

1.6 Pulse Mode

The pulse mode is selectable as either single or double pulse operation.

1.6.1 Single Pulse

One pulse per cycle occurs at the main pulse outputs at the end of the delay period.

1.6.2 Double Pulse

Two identical pulses per cycle occur at the outputs: the first occurs approximately 40 nanoseconds after the reference trigger; the second at a time determined by the pulse delay controls.

1.7 Pulse Delay

Pulse delay is continuously variable from approximately 40 nanoseconds with respect to the reference trigger (60 nanoseconds with respect to an external trigger) to 10 milliseconds in six decade ranges. It is variable over 70% of the pulse period. Delay settings greater than the pulse period cause the output pulse and reference trigger to be counted down. The advanced trigger is unaffected. Stable countdown ratios greater than 100:1 are possible.

1.8 Pulse Width

Pulse width is continuously variable (measured at ± 50% point of rise and fall) from 35 nanoseconds to 10 milliseconds in six decade ranges. Maximum duty cycle is at least 70%.

1.9 Main Pulse Output

Amplitude is continuously variable from 0.5 volts to 10 volts into 50 ohms with simultaneous positive and negative dc coupled outputs (baselines are at ground). The source impedance decreases with amplitude and is approximately 50 ohms at amplitudes less than 5 volts.

1.10 Rise and Fall Time

Rise time is less than 5 nanoseconds. Fall time is typically less than 7 nanoseconds (10 nanoseconds maximum) with the output terminated in a 50 ohm resistive load.

1.11 Jitter

Repetition rate, delay, and width jitter are less than 0.15% (typically 0.1%) on each range (within the highest decade on the width and delay ranges with more than 10:1 coverage).

1.12 Waveform Aberration

Overshoot, preshoot, ringing, and top slope aberration are typically less than ±5% (with a maximum of ±7%) for amplitudes greater than 3 volts (with properly connected 50 ohm terminations).

1.13 Output Protection

Output stages will not be damaged by any combination of panel control settings and will withstand short circuits to ground of any duration. The unit is not rated for operation into loads at other than ground potential.

1.14 Output Mixing

Same polarity outputs of multiple units may be diode mixed with a negligible loss of amplitude. Same or opposite polarity outputs may be resistor mixed with a resultant loss of amplitude. Units may not be directly coupled together.

1.15 Operating Temperature

The unit is designed for operation in ambient temperatures of 0^{o} to 50^{o} C (32^{o} to 122^{o} F).

1.16 Power Required

Approximately 30 watts at 105-125/210-230 volts and 50-400 hertz ac is required. All power supplies are regulated against line and load changes.

1.17 Physical Characteristics

Weight is approximately 8 pounds. Dimensions are 3-1/2 inches high by 8-1/2 inches wide and 11 inches deep. Each instrument is furnished with an attached line cord and NEMA 3-prong plug. The cabinet and front panel are brushed aluminum with black etched markings and trim. The russet brown top, bottom and side panels are removable. A tilt-up bracket is provided. Units may be rack mounted by Type 1005 (single unit) or Type 1006 (dual unit) Rack Mounting Sets.

1.18 Accessories Available (Figure 1-1)

1.18.1 Type 1005 Rack Mounting Set

This set mounts a single unit in a standard 19 inch wide by 3-1/2 inch high rack panel offset to either side of center.

1.18.2 Type 1006 Rack Mounting Set

This set mounts two units in a standard 19 inch wide by 3-1/2 inch high rack panel.

1.18.3 Type 2003A 50 Ohm Termination

This specially designed load provides proper termination for 50 ohm coaxial cables used to carry fast-rise pulse outputs.

1.18.4 Type 2101 Inverting Transformer

The 2101 transformer inverts the positive trigger output (advanced or reference) for applications requiring a negative synchronous trigger.

1.18.5 Type 2302 Mixing Unit

The mixing unit combines two same polarity multiple unit outputs with 1 volt loss of amplitude.

1.18.6 Type 2401 Variable Integrator

This accessory provides a means of varying pulse rise and fall times.

1.18.7 Instruction Manual

One operation and maintenance handbook is supplied with each unit. Additional handbooks are available at a slight additional charge.

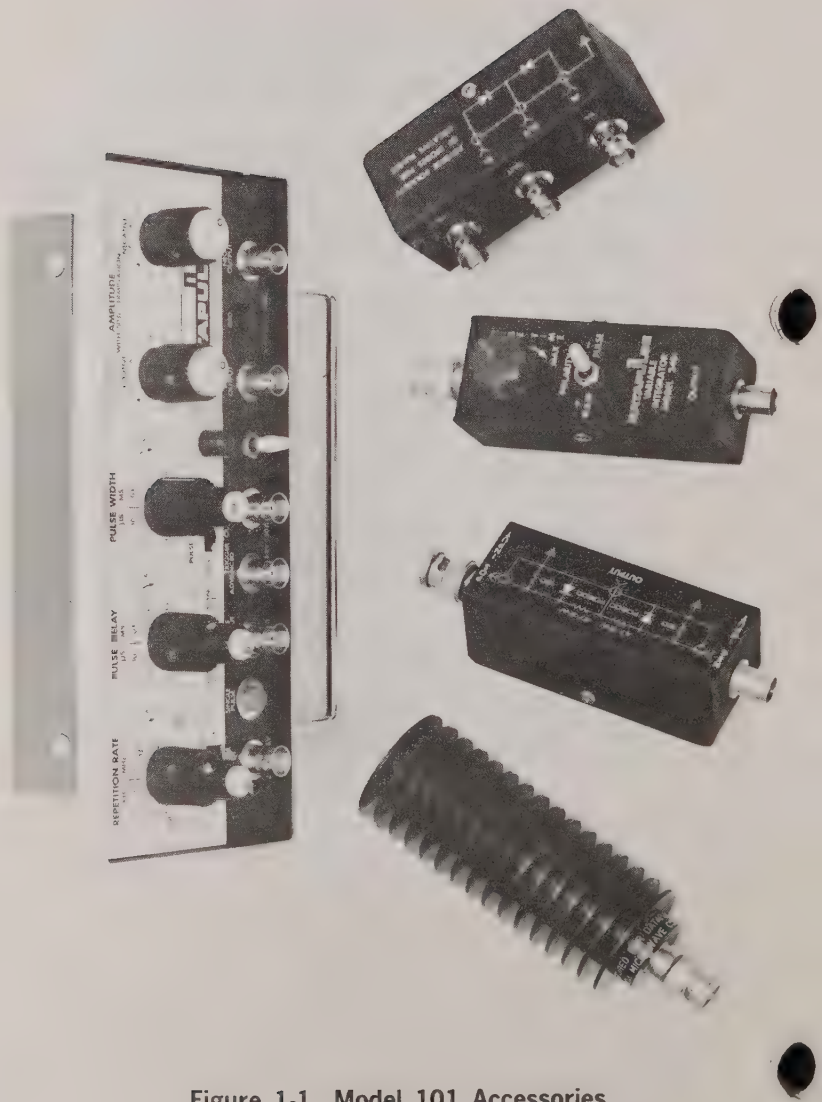


Figure 1-1. Model 101 Accessories.

SECTION II
OPERATION

2.1 General Information

WARNING

Do not directly connect the outputs to other outputs or voltages. Refer to paragraph 2.4.8 for output mixing instructions.

Pulse amplitude, width, delay, and repetition rate are continuously variable and provide an infinite variety of pulse parameter combinations to satisfy most test requirements. Single or double pulse operation, simultaneous positive and negative outputs, flexible external gating and triggering, and countdown capabilities extend the instrument's versatility. Extra operating convenience is gained through broad range coverage of pulse width and delay by 1000:1 vernier control. Available accessories provide for variable rise and fall times, reference trigger inversion, low loss output mixing and minimum distortion load termination.

Gating capabilities consist of synchronous, asynchronous and coincidence gating. The output pulse train is synchronized to the leading edge of an externally applied gate waveform in the synchronous mode. In the asynchronous mode, the output pulse train begins with the first advance trigger after the gate pulse occurs and continues until the gate pulse subsides; the output is quiescently off while the rate oscillator continuously provides advance trigger outputs. The reference trigger is gated in both modes while the advance trigger is gated in the synchronous mode only. Coincidence gating is achieved by application of both a gate signal and an external trigger pulse so that output pulses occur only when the two are coincident.

Frequency division by synchronous countdown is obtained from either internal or external triggering when the delay is set greater than the trigger period and the output pulse rate is a subharmonic of the trigger rate. The refer-

ence trigger occurs at the subharmonic rate in either case while the advanced trigger occurs at the oscillator rate for internal triggering and is turned off for external triggering.

2.2 Controls and Connectors

2.2.1 Power Switch

The POWER switch connects ac power to the transformer primary and lights the pilot lamp when it is turned ON.

2.2.2 Repetition Rate

The REPETITION RATE rotary switch selects either the triggered mode or the repetition rate range for internally triggered operation. The smaller vernier knob provides continuously variable control for all range settings. There are six decade ranges and the instrument is set to the rate indicated by the rotary switch when the vernier knob is fully clockwise.

The SINGLE PULSE position permits the unit to be triggered manually for one cycle of output by the SINGLE PULSE pushbutton.

The EXT TRIG SLOPE (+) and (-) positions provide for instrument triggering from an external source by either a positive or negative going waveform.

In the LINE SLOPE positions the unit is triggered from either the positive or negative going slope of the ac line voltage waveform.

The TRIGGERING LEVEL control determines the (+) or (-) amplitude of a signal that will trigger the unit for either external or line voltage operation.

A BNC connector is provided for the external TRIGGER INPUT.

2.2.3 Pulse Delay

The PULSE DELAY rotary switch selects one of six decade ranges and the smaller vernier knob provides

continuously variable control for each range. The instrument is set to the delay indicated by the range switch when the vernier is fully clockwise.

2.2.4 Pulse Width

The PULSE WIDTH rotary switch selects one of six decade ranges and the smaller vernier knob provides continuously variable control for each range. The instrument is set to the width indicated by the range switch when the vernier is fully clockwise.

2.2.5 Amplitude

The POSITIVE and NEGATIVE pulse AMPLITUDE knobs provide continuously variable control of the simultaneously occurring main output pulses. The baseline for both outputs is at ground potential.

The POS OUTPUT and NEG OUTPUT jacks provided for load coupling are BNC connectors. The GRD jack provides access to the instrument ground for test connections.

2.2.6 Gate Mode

The main outputs will be continuous when the GATE MODE switch is in the NON-GATED position but will be interrupted and will occur in gated bursts, as controlled by an externally applied gate signal, in either the SYNC or the ASYNC position.

In the SYNC position, the repetition rate generator is disabled and the main output pulses occur only during the pulse interval of an applied gate signal. The first main pulse of a gated burst is synchronized to the leading edge of the gate pulse and both trigger outputs are gated.

The pulse delay circuit rather than the repetition rate generator is disabled in the ASYNC position, and on internally triggered operations the advance trigger is available as a clock pulse. Main output and reference trigger pulses begin with the first rate generator pulse after the start of a gate pulse and continue until the gate pulse subsides for either internal or external triggering.

A BNC connector is provided for the ENABLING GATE INPUT.

2.2.7 Pulse Mode

Single or double pulse operation is selected by the PULSE MODE switch. In the SGL position, one pulse per cycle occurs at the outputs delayed from the reference trigger by a period set on the delay controls. Two identical pulses occur when the switch is in the DBL position; the first is delayed for approximately 30 nanoseconds from the reference trigger and the second is delayed for a period determined by the delay controls.

2.2.8 Trigger Output

The ADVANCE and REFERENCE trigger BNC jacks provide for TRIGGER OUTPUT connections.

2.2.9 Power Input

A 6-foot, 3-wire ac line cord with a NEMA 3-prong plug is attached to the back of the unit.

The 115/230 selector switch on the back panel provides for operation from either a 115 or a 230 line voltage source.

Overload protection is provided by a 1 ampere cartridge type fuse mounted on the back panel.

2.3 Functional Verification

The following procedure provides a brief check, and an introduction to the controls of the instrument.

WARNING

The instrument is designed for resistive loads only. Reactive loads connected directly to the output will produce pulse distortion. Inductive loads may damage the instrument. Refer to paragraphs 2.4.4 through 2.4.6 for nonstandard load connections.

2.3.1 Equipment (or equivalent) Required

a. A general purpose oscilloscope of at least 15 megahertz bandpass with triggered sweep.

NOTE: The general purpose oscilloscope is adequate for the basic tests outlined here but a sampling oscilloscope is required for a full range check to verify specifications. Coaxial attenuators for the main pulse and trigger outputs may also be needed because most sampling oscilloscopes will be damaged by inputs greater than 250 millivolts.

b. A 50 ohm coaxial termination capable of 2 watts dissipation such as a Datapulse 2003A Power Termination.

NOTE: A one watt termination is adequate in most cases but should be used with care because pulse output power will approach 2 watts for high duty cycle waveforms at full amplitude.

c. A general purpose signal generator capable of delivering 2 volts into 500 ohms (the square wave amplitude calibrator of many oscilloscopes is adequate).

d. Three long (3 feet) and one short (6 inches) 50 ohm coaxial cables with BNC connectors and one BNC Tee connector.

2.3.2 Test Connections and Settings

WARNING

Check the position of the 115/230 volt selector switch (near the line cord on the back) for correct voltage before connecting the cord.

a. Connect the instrument to a suitable power source.

b. Connect a 50 ohm coaxial cable from the POS OUTPUT to the oscilloscope input and terminate the cable with the 50 ohm coaxial termination at the oscilloscope (short coaxial cable).

c. Connect a 50 ohm cable from the REFERENCE TRIGGER OUTPUT to the oscilloscope trigger input.

d. Set the instrument controls as follows:

Control	Setting
POWER switch	off
REPETITION RATE selector	1.0 MHz
REPETITION RATE vernier	midrange
PULSE DELAY selector	1.0 μs
PULSE DELAY vernier	midrange
PULSE WIDTH selector	1.0 μs
PULSE WIDTH vernier	fully clockwise
POSITIVE AMPLITUDE	5V
NEGATIVE AMPLITUDE	5V
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL

e. Set the oscilloscope sweep to 0.2 μs/cm and the vertical sensitivity to 2V/cm.

2.3.3 Main Pulse Output

a. Turn the POWER switch ON. Note that the pilot lamp lights and a rectangular pulse (approximately 5 volts high and 1 microsecond wide with a flat top and near vertical leading and trailing edges) appears on the oscilloscope.

b. Turn the POSITIVE AMPLITUDE control and note that the amplitude decreases down to 3 volts and increases up to 10 volts uniformly without any noticeable effect on waveshape. Return the amplitude control to the 5V position.

c. Disconnect the coaxial cable from the POS OUTPUT and reconnect it to the NEG OUTPUT. Note that the negative pulse looks like the positive pulse inverted.

d. Repeat step (b) for the NEGATIVE AMPLITUDE control. Reconnect the coaxial cable to the POS OUTPUT.

e. Turn the PULSE WIDTH vernier counterclockwise. Note that the pulse width follows the control and decreases smoothly. Turn the vernier to its fully clockwise position.

f. Turn the PULSE DELAY vernier and note that the pulse follows the controls and moves smoothly to the left and to the right. Return the vernier to its minimum position.

g. Set the PULSE WIDTH selector to 0.1 μs and the REPETITION RATE selector to 10 MHz. Note that two or three pulses appear on the oscilloscope and that the number of pulses increases when the REPETITION RATE vernier is turned clockwise.

2.3.4 Double Pulse Mode

a. Retain the test connections of paragraph 2.3.2 and set the oscilloscope sweep to 1.0 μs/cm.

b. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	0.1 MHz
REPETITION RATE vernier	fully clockwise
PULSE DELAY selector	10 μs
PULSE DELAY vernier	fully counter-clockwise
PULSE WIDTH selector	1.0 μs
PULSE WIDTH vernier	fully clockwise

Control	Setting
POSITIVE AMPLITUDE	5V
NEGATIVE AMPLITUDE	any position
GATE MODE switch	NON-GATED
PULSE MODE switch	DBL

c. Turn the PULSE DELAY vernier clockwise and note that a second pulse appears on the oscilloscope moving smoothly from left to right, following the control.

2.3.5 Single Pulse Operation

a. Retain the test connections of section 2.3.2, set the oscilloscope sweep to 1.0 ms/cm and its triggering mode for single sweep triggering.

b. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	SINGLE PULSE
PULSE DELAY selector	1.0 MS
PULSE DELAY vernier	fully clockwise
PULSE WIDTH selector	1.0 MS
PULSE WIDTH vernier	midrange
POSITIVE AMPLITUDE	5V
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL
Remaining controls	any position

c. Press the SINGLE PULSE button and note that only one pulse appears on the oscilloscope each time the button is pressed.

2.3.6 External and Line Slope Triggering

a. Retain the test connections of the previous section and set the oscilloscope sweep to 0.5 ms/cm.

b. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	(+) EXT TRIG SLOPE
PULSE DELAY selector	1 MS
PULSE DELAY vernier	fully counter-clockwise
PULSE WIDTH selector	1 MS
PULSE WIDTH vernier	midrange
POSITIVE AMPLITUDE	5V
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL
Remaining controls	any position

c. Connect either the signal generator or the oscilloscope amplitude calibrator to the TRIGGER INPUT jack. If the calibrator is used, set its amplitude to 1.0 volt (its frequency is fixed at 1 kHz). When a signal generator is used, adjust its frequency to 1 kHz and set its amplitude to 2 volts.

d. Adjust the TRIGGERING LEVEL control until several (approximately 5) pulses appear. Switch the REPETITION RATE selector to (-) EXT TRIG SLOPE and verify that the pulses do not disappear (the trigger input is capacitor coupled).

e. Turn the REPETITION RATE selector to (-) LINE SLOPE, the PULSE WIDTH selector to 10 MS and the oscilloscope sweep to 5 ms/cm.

f. Adjust the TRIGGERING LEVEL control until several (3 or 4) pulses appear. Switch the REPETITION RATE selector to (+) LINE SLOPE and note that the pulses do not disappear.

2.3.7 External Gating

a. Retain the test connections of paragraph 2.3.2, set the oscilloscope sweep to 0.5 ms/cm, and connect the amplitude calibrator to the ENABLING GATE INPUT jack.

b. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	0.1 MHz
REPETITION RATE vernier	fully counter-clockwise
PULSE DELAY selector	0.1 MS
PULSE DELAY vernier	fully counter-clockwise
PULSE WIDTH selector	0.1 MS
PULSE WIDTH vernier	midrange
POSITIVE AMPLITUDE	5V
GATE MODE switch	SYNC
PULSE MODE switch	SGL
Remaining controls	any position

c. Verify that the pulses occur in gated bursts. Turn the GATE MODE switch to the NON-GATED position and note that the pulse output is continuous. Switch to the ASYNC position and note that the output is gated but unstable.

2.4 Operating Instructions

2.4.1 Idle Output

When only one output is being used, radiation from the other output may cause ringing of the output in use. This can be conveniently avoided by reducing the amplitude of the idle output to a low voltage so that it is terminated in its characteristic impedance by the attenuator.

2.4.2 Output Termination

Fifty ohms is used for the output impedance because of the wide use and availability of 50 ohm cables, connectors, and accessories. To get clean wave shapes with fast transition times, both the interconnecting cable and the load termination must have an impedance of 50 ohms. The terminating impedance must not vary more than ±5% if instrument specifications are to be met. Proper loading is conveniently obtained by using a Datapulse 2003A Power Termination which also eliminates the need to contain pulse amplitudes and duty cycles within low voltage load limits.

2.4.3 Output Cabling

When the pulse generator is connected to a load that is several feet away, clean waveforms with low distortion are maintained by using a 50 ohm coaxial cable terminated in 50 ohms at the load rather than at the instrument. Terminating at the pulse generator, using clip leads, or using coaxial cable with the wrong characteristic impedance will have the same pulse distorting effect as terminating in the wrong impedance.

2.4.4 Nonlinear Loads

Operating directly into nonlinear devices such as transistors and diodes that exhibit high impedance in one direction and low impedance in the other causes waveform distortion. This can be prevented by terminating the pulse generator in a network that reflects uniform loading in both directions. Two methods for driving the base of a transistor, or operating into a diode (the base-emitter junction of a transistor resembles a diode) are illustrated in Figure 2-1. In the resistor coupled network, transistor Q_L is biased off between pulses and is turned on during the pulse interval, while in the capacitor coupled circuit Q_L is quiescently on and is turned off by the applied pulse.

Valves for resistors R_1, R_2, and R_3 and capacitor C_1 depend primarily on the transistor characteristics in both circuits. R_1 is calculated from the equations given in the fig-

ure to provide proper termination for the pulse generator (50 ohms) and prevent ringing. C_2, in the capacitor coupled network, depends on pulse width and repetition rate, and is determined by the given equations. For a PNP transistor, the polarity of the input pulse, the applied voltage, and the diode are reversed. In both networks, load mismatch and waveform distortion are more pronounced at fast rise and fall times.

2.4.5 Output Decoupling

An emitter follower may be used to decouple the output from a nonlinear load when the passive networks of Figure 2-1 are unsuitable. The circuits of Figure 2-2 are useful, for example, when more power is required than can be obtained from either the resistor or the capacitor coupled circuit. The transistor selected must have enough power and gain to meet load requirements and should have high frequency response characteristics with low capacity input for fast transition times and minimum pulse distortion. The 22 ohm resistor in the output is a parasitic suppressor that reduces pulse aberrations. The value of emitter resistor (R_E) and the operating voltage (V_C) depends on the load current and voltage requirements.

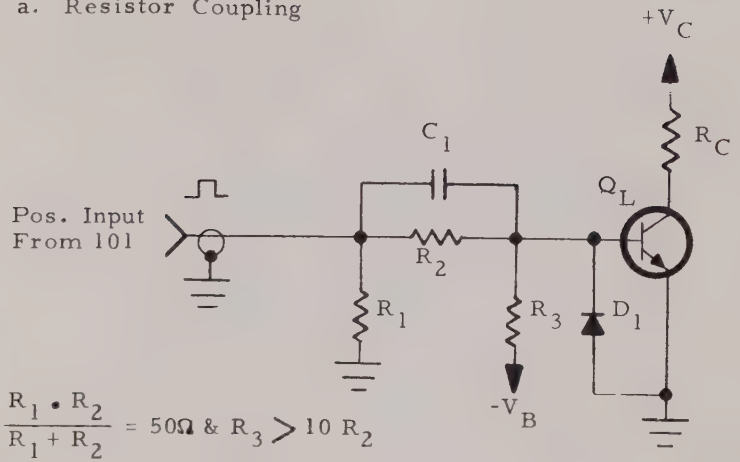
2.4.6 Reactive Loads

Reactive loads connected directly to the output will produce pulse distortion; inductive loads may damage the instrument. When it is necessary to drive an inductive load such as a pulse transformer, the instrument should be protected against the inverse voltages generated by energy stored in the transformer. Figure 2-3 shows how diodes may be used to dampen the reverse voltage swings and prevent the output transistors from being exposed to voltages above their inverse ratings.

2.4.7 Duty Cycle

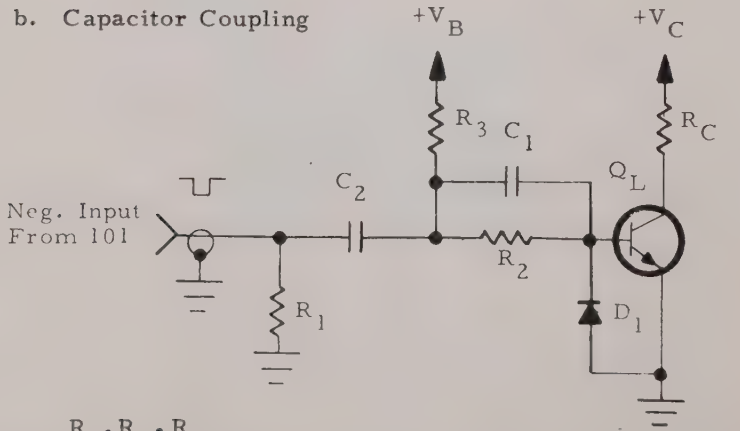
Output instability may occur at high duty cycle operation due to failure of the width or delay circuit. Using the lowest ranges that will give the required settings will sometimes correct the problem. This helps stabilize the width and delay circuits by reducing their recovery times to a minimum and extends the duty cycle range of the instrument to its full capability.

a. Resistor Coupling



$$\frac{R_1 \cdot R_2}{R_1 + R_2} = 50\Omega \;\&\; R_3 > 10\,R_2$$

b. Capacitor Coupling



$$\frac{R_1 \cdot R_2 \cdot R_3}{R_1 \cdot R_2 + R_2 \cdot R_3 + R_1 \cdot R_3} = 50\Omega,\; 50\,C_2 > \text{Pulse Width} \;\&\; \frac{3}{50C_2} > \text{Rep Rate}$$

Figure 2-1. Networks For Transistor Load.

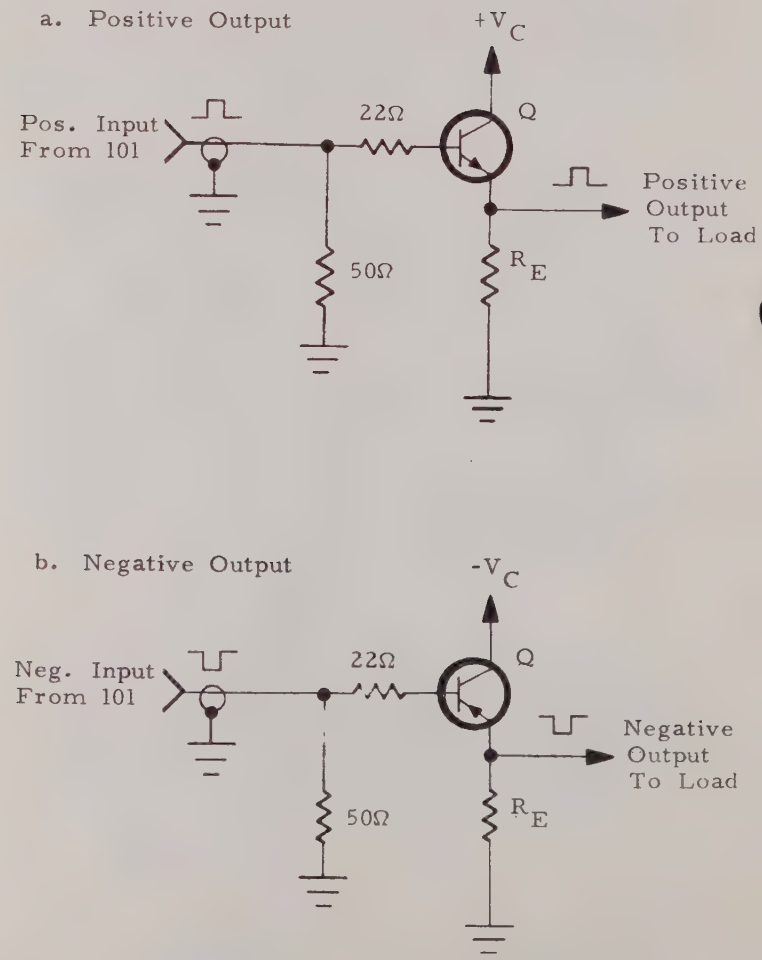
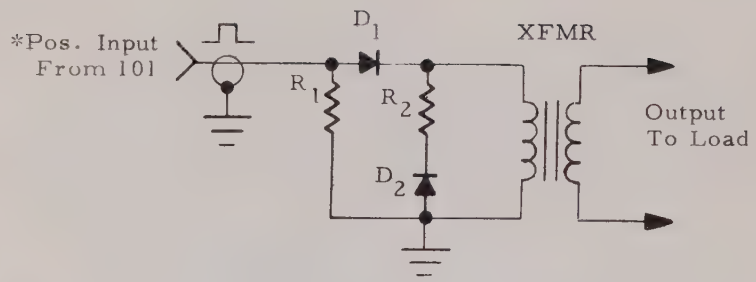


Figure 2-2. Output Decoupling Circuits.



R_1 = 75 - 150Ω, R_2 = 200 - 500Ω, Diodes may be 1N995s.

* Reverse Diode Polarity for Negative Pulse Input.

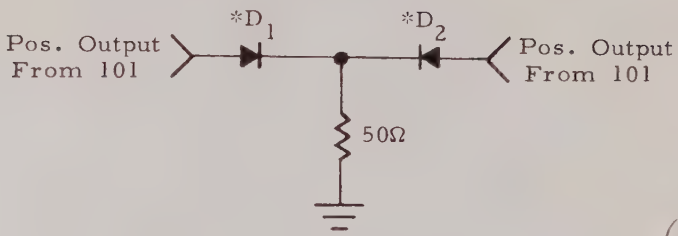
Figure 2-3. Reverse Voltage Protection.

2.4.8 Output Mixing

Same polarity outputs may be diode mixed and opposite polarity outputs may be resistor mixed, but units may not be directly coupled together nor connected to loads at other than ground potential. Pulse amplitude reduction is substantial for resistor mixing but is negligible for diode mixing. In general, mixing will degrade transition times and cause pulse distortion due to unavoidable reactive components in the coupling circuit. Best results for combining two same polarity outputs is obtained by using a Datapulse 2302 Pulse Mixer.

When two or more outputs are mixed, the loading circuit must protect all outputs from same polarity voltages above the base-to-emitter breakdown voltage of the output transistors (5 volts). Diodes provide excellent protection because they have low forward resistance and are back biased by same polarity outputs. Resistor networks may be used for voltage division but should be such that each instrument is terminated in its characteristic impedance (50 ohms). Correct coupling connections for mixing two same or opposite polarity outputs are given in Figure 2-4.

a. Same Polarity Mixing.



* Reverse Diodes for Negative Outputs

b. Opposite Polarity Mixing.

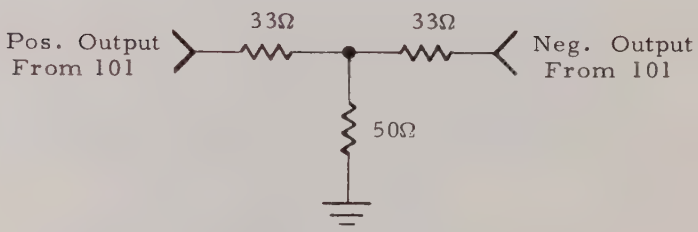


Figure 2-4. Output Mixing.

2.4.9 Low Level Outputs

Pulse distortion due to overshoot may be excessive at low outputs. The aberrations can be reduced by using a times ten attenuator for outputs below one volt. A Tektronix Number 011-059 T-pad is suitable but must be restricted to low duty cycle operation for outputs above one-half volt because it is rated at one-half watt.

2.4.10 Variable Rise Time

The Datapulse 2401 Rise Time Integrator, available as an accessory, provides continuously variable control of rise time up to more than 40 nanoseconds. The unit connects in series with the output and may be used with either positive or negative pulses. No external power is required.

2.4.11 Negative Reference Triggers

The positive trigger outputs may be adapted to applications requiring negative reference triggers by means of the Datapulse 2101 Inverting Transformer, available as an accessory.

2.5 Definitions

Refer to Figure 2-5 for a graphical representation of the following definitions.

2.5.1 Main Output

The principal output of the instrument, available at the POS and NEG OUTPUT jacks.

2.5.2 Pulse Delay

The separation in time of the main pulse from the reference trigger in the single pulse mode, or the separation between the first and second pulse in the double pulse mode, measured between the 50% points of the leading edges.

2.5.3 Pulse Width

The pulse duration measured at the 50% point of the leading and trailing edges.

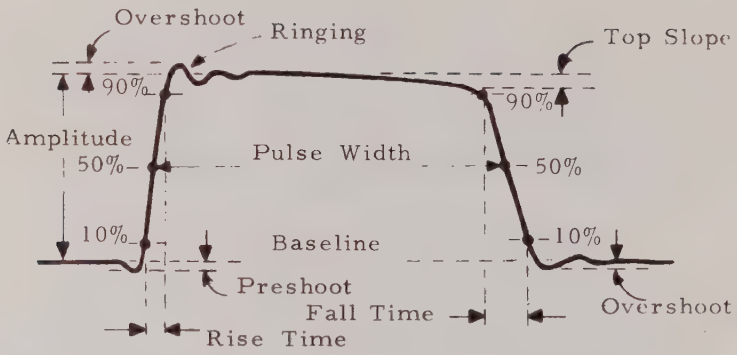


Figure 2-5. Output Pulse Characteristics.

2.5.4 Rise and Fall Time

The transition time of the pulse leading and trailing edges measured between the 10% and 90% amplitude levels.

2.5.5 Duty Cycle

The ratio of the pulse on time to the total time of the pulse period.

2.5.6 Trigger Outputs

Synchronous trigger pulses occuring at the repetition rate of the main pulse and available at the ADVANCED and REFERENCE TRIGGER OUTPUT jacks.

Reference Trigger: Zero time reference for the main pulse.

Advanced Trigger: Auxiliary reference trigger available on internally triggered operations.

2.5.7 Internal Operation

The mode of operation in which the synchronizing clock pulse for the instrument is supplied internally by the r oscillator and governed by the REPETITION RATE controls.

2.5.8 External Operation

The mode of operation in which the synchronizing clock pulse is supplied and controlled by an external source connected to the TRIGGER INPUT jack.

2.5.9 Gated Operation

In this mode of operation, the main outputs are turned on for the duration of pulses applied to the ENABLING GATE INPUT jack and off between gate pulses so that the main pulses occur in gated bursts.

2.5.10 Waveform Aberrations

Any small deviation from the standard wave shape pattern including overshoot, preshoot, ringing and top slope expressed in percentage of pulse amplitude.

Ringing: Damped oscillations occurring on the leading corner of the pulse top or at the base of the trailing edge.

Overshoot: Maximum excursion above the pulse top at the leading edge or dip below the baseline at the trailing edge caused by ringing.

Preshoot: Dip below the baseline at the leading edge, or rise above pulse top at the trailing edge.

Top Slope: Pulse top sag or droop.

2.5.11 Jitter

Small rapid variations in a waveform observed as unsteadiness of the oscilloscope trace and indicating cycle to cycle variations of pulse parameters.

2.5.12 Clock Pulse

The basic synchronous trigger pulse that establishes the time base for all circuits within the instrument and determines the repetition rate of the main pulse.

2.5.13 Pulse Mode

Refer to paragraph 2.2.7 (Pulse Mode) under paragraph 2.2 (Controls and Connectors).

2.5.14 Line Slope

Refer to paragraph 2.2.2 (Repetition Rate) under paragraph 2.2 (Controls and Connectors).

SECTION III

THEORY OF OPERATION

3.1 General Description

Refer to the Block Diagram (Figure 3-1) and the waveform diagrams (Figure 3-2) for the following discussions.

The clock pulse that synchronizes the operation of all circuits within the instrument is either supplied by an external source or is provided internally by the variable frequency rate oscillator. On internal operation, the output of the rate oscillator (1C) is applied to the trigger multivibrator and to the advance trigger amplifier. The advance trigger amplifier provides an auxiliary reference trigger output on internally triggered operations. The trigger multivibrator generates the trigger pulse (1D) that governs the remaining circuits for all modes of triggering.

For either external or line slope (line voltage) triggering, the rate oscillator is turned off and the external trigger amplifier is turned on so that its output (1B) drives the trigger multivibrator. Both the rate oscillator and the external trigger amplifier are off for single pulse operation when a pushbutton is used to trip the trigger multivibrator for one cycle of output. No advance trigger occurs during external, line slope, or manual triggering.

The AND gate permits the delay multivibrator to either be driven continuously by the trigger multivibrator or to be turned on and off by gate pulses from the external gate amplifier. The main output is continuous in the nongated mode of operation but is interrupted and occurs in gated bursts in either of the two gated modes of switch S2. The external gate amplifier turns the rate oscillator on and off in the synchronous mode so that the output pulse train is synchronized to the leading edge of the gating waveform and is turned off at the trailing edge. The advance trigger output is also gated in this mode.

In the asynchronous mode, the output of the external gate amplifier is applied to the gate emitter follower to

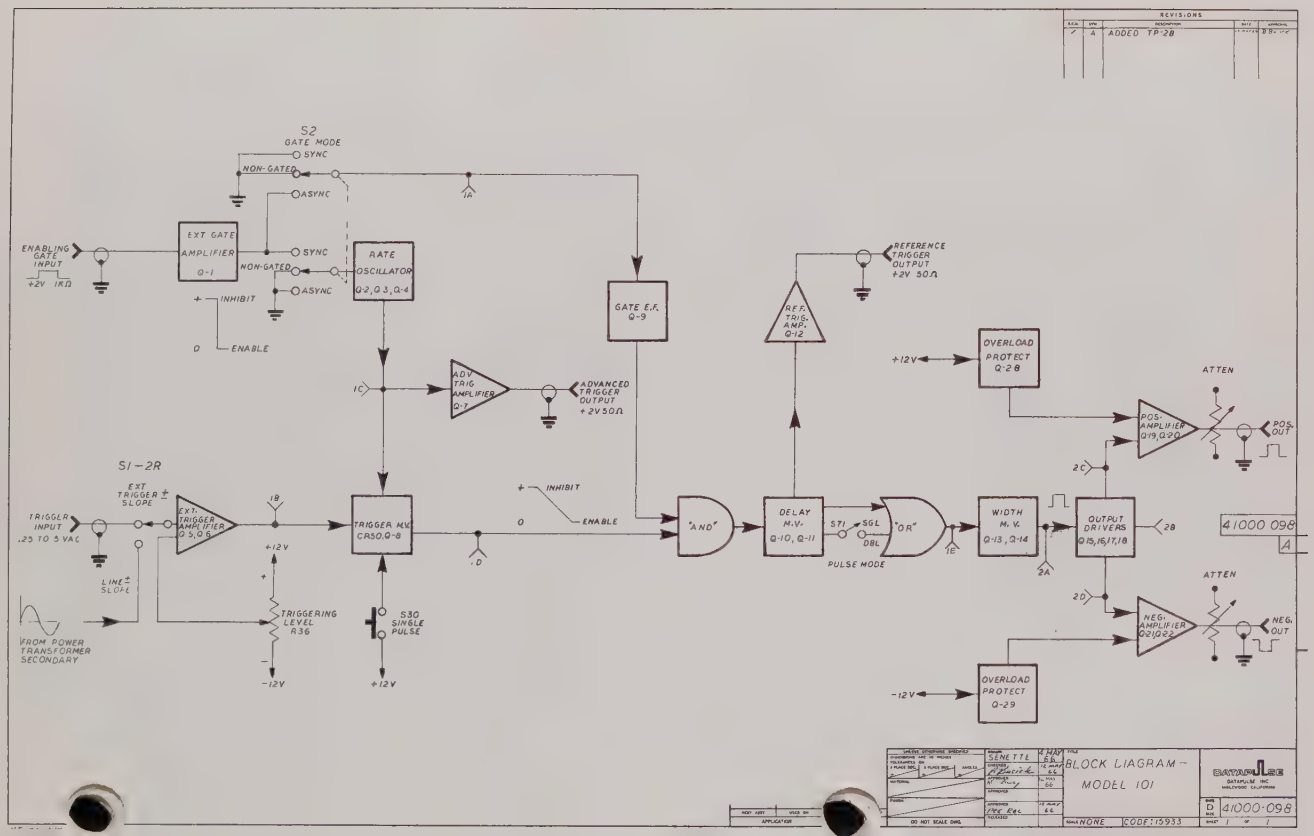
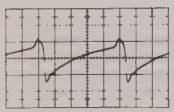
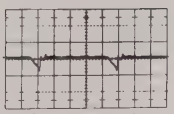


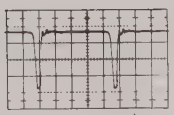
Figure 3-1. Block Diagram.



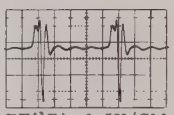
TP(P), 0.5V/CM
Rate Oscillator



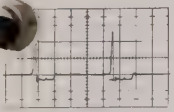
TP(1B), 0.5V/CM
Trigger MV Input



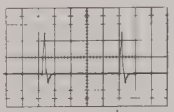
TP(1C), 0.5V/CM
Oscillator Output



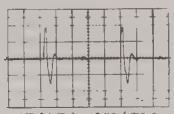
TP(1D), 0.5V/CM
Trigger MV Output



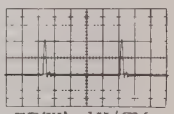
TP(F), 1V/CM
Advance Trigger



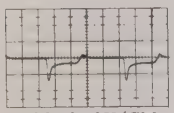
TP(S), 1V/CM
Delay MV Output



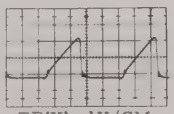
TP(AD), 1V/CM
Pulse Xfmr. Input



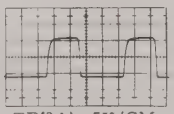
TP(W), 1V/CM
Reference Trigger



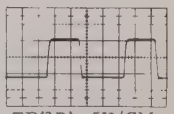
TP(1E), 1V/CM
Pulse Xfmr. Output



TP(X), 1V/CM
Width MV Output

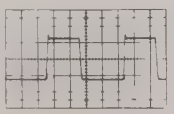


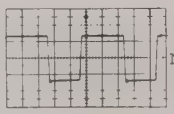
TP(2A), 5V/CM
Pos. Driver Input



TP(2B), 5V/CM
Neg. Driver Input

TP(2C), 5V/CM
Pos. Ampl. Input
& Pos. Output





TP(2D), 5V/CM
Neg. Ampl. Input
& Neg. Output

Figure 3-2. Waveform Diagrams. REPETITION RATE: 2 MHz, PULSE DELAY: Minimum, PULSE WIDTH: 0.2μs, AMPLITUDES: 6V, GATED MODE: NON-GATED, PULSE MODE: SGL. OSCILLOSCOPE: Real Time, 50 MHz Bandpass, 10 MΩ Probe, 0.1 μs/CM Sweep Speed, and zero time at same point on all diagrams.

Figure 3-2. Waveform Diagrams.

control the delay multivibrator rather than the rate oscillator. The output of the trigger multivibrator is gated but the advance trigger output is continuous because the rate oscillator is not interrupted. The output pulse train begins with the first advance trigger output after the gate pulse occurs and continues until the gate pulse subsides. The reference trigger output which is taken from the delay multivibrator is gated in both modes.

The leading and trailing edges of the delay multivibrator waveform are differentiated to produce two trigger pulses separated by the multivibrator duration (period). These are applied through the OR gate to the width multivibrator, and the trigger at the beginning of the delay interval is also applied to the reference trigger amplifier. Switch S7 disconnects the leading trigger pulse from the input to the width multivibrator (1E) in the single pulse mode so that the main output is a single pulse separated in time from the reference trigger output by the delay period.

In the double pulse mode, the width multivibrator is turned on twice during each cycle to produce two identical pulses. The first pulse occurs approximately 30 nanoseconds after the reference trigger output and the second at the end of the delay multivibrator duration. Pulse width is determined by the width multivibrator duration in either single or double pulse operation.

The output of the width multivibrator (2A) is applied to the output drivers which raise the current level to generate the drive (2C) for the positive output amplifier. An inverted version (2B) generates the drive (2D) for the negative output amplifier. Variable bridged-T attenuators provide output pulse amplitude control. The current sensitive overload protection circuits turn their respective power supplies off when either output is overloaded.

3.2 Circuit Description

3.2.1 Repetition Rate Oscillator

The repetition rate oscillator, shown in simplified form in Figure 3-3 is an emitter coupled multivibrator. Transistors Q2 and Q4 comprise the basic oscillator and Q3

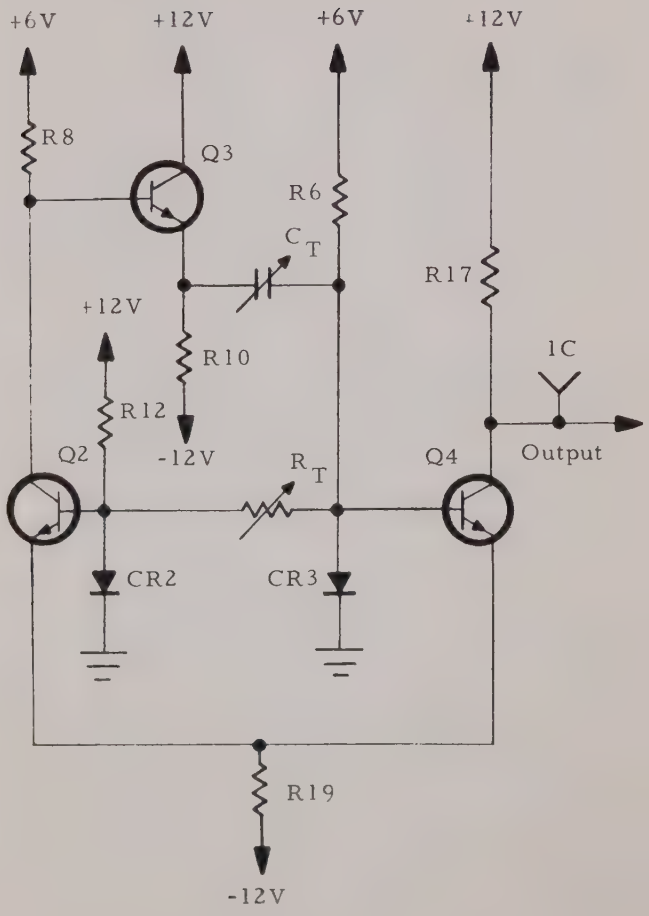


Figure 3-3. Repetition Rate Oscillator.

is an emitter follower. The voltage waveform occurring at the base of Q4 is illustrated in Figure 3-2 (waveform diagrams) for a repetition rate of two megahertz.

To trace the cycle of operation, assume that Q2 has just turned off and Q4 is starting to conduct. A positive voltage step occurs at the collector of Q2 (and the base of Q3) because the voltage drop in resistor R8 is suddenly reduced when the collector current in Q2 is turned off. This positive transient is transferred through emitter follower Q3 and timing capacitor C_T to the base of Q4 and drives Q4 into a high state of conduction. The voltage drop produced in resistor R19 by emitter current in Q4 holds the emitters of both Q2 and Q4 near ground potential. Q3 conducts freely during the positive transient and provides a low impedance path for C_T so that it charges through CR3.

The charging current for C_T quickly subsides because the base of Q4 is clamped slightly above ground by CR3, and C_T cannot charge above this voltage level. As the positive voltage at the base of Q4 drops off, an amplified reduction in its emitter current is produced by the declining base current. The resulting decrease in the voltage drop in R19 drives the emitters of Q2 and Q4 negative. When the emitter of Q2 becomes negative with respect to its base, which is clamped near ground by CR2, Q2 turns on and conducts through R8.

The negative transient applied to the base of Q3, when Q2 is turned on, drives Q3 to near cutoff and the negative voltage is transferred to the base of Q4 through C_T. This cuts Q4 off sharply and regeneratively drives Q2 into saturation. CR3 presents a high impedance to this negative voltage at the base of Q4 and C_T must charge through timing resistor R_T. This causes the base voltage of Q4 to rise exponentially toward the slightly positive voltage of CR2. Emitter current in Q2 holds the emitter of Q4 near ground, and when its base voltage becomes positive with respect to its emitter, Q4 starts to conduct. This cuts Q2 off by driving its emitter positive with respect to its base and starts the cycle over again.

3.2.2 Trigger Multivibrator

Tunnel diode CR50, transistor Q8, and their related circuit components comprise the trigger multivibrator as shown in Figure 3-4. It is driven by the rate oscillato

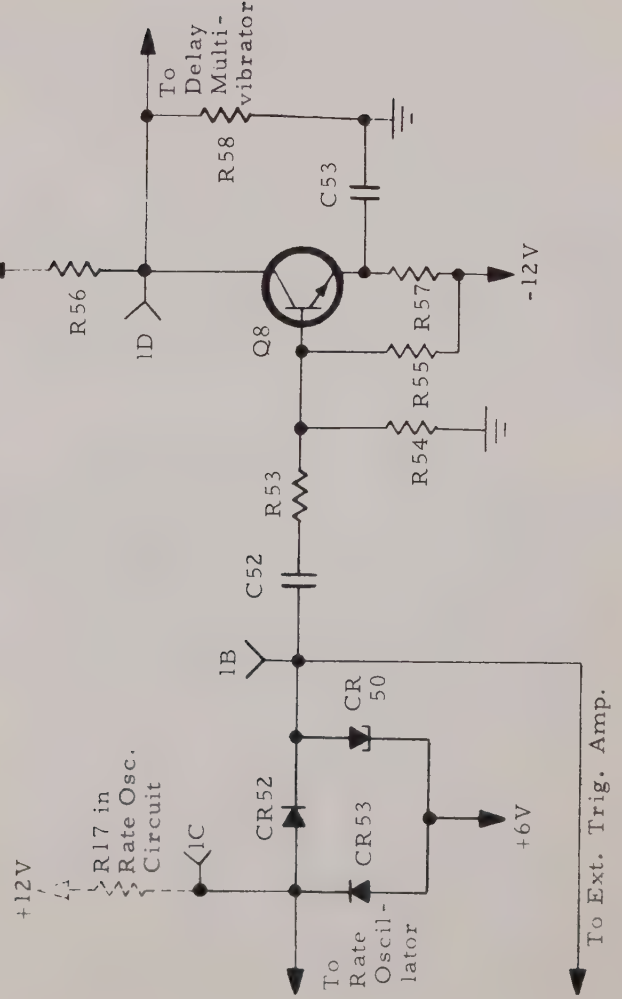


Figure 3-4. Trigger Multivibrator.

for internally triggered modes of operation and generates the trigger pulse that governs the remaining circuits. The external trigger amplifier drives this circuit for either external or line voltage triggering and it is tripped directly by the +12 volt supply for manual single pulse operation.

The negative going rectangular waveform that drives the trigger multivibrator for the internal triggering mode is taken from the collector of Q4 (test point 1C) and occurs when Q4 is regeneratively turned on and off. When Q4 is off, current flows from the +12 volt supply through resistor R17, diode CR52, and tunnel diode CR50 to the +6 volt supply; CR50 is in its high voltage state and the voltage at the collector of Q4 is equal to +6 volts plus the forward voltage drop in CR and CR52. When Q4 is turned on, CR53 clamps the collector of Q4 to +6 volts less the forward drop in CR53, and CR50 is switched to its low voltage state.

Waveform (1B) is a negative going pulse that occur when CR50 is switched from its high voltage state to its low state and back again as Q4 turns on and off. This waveform is differentiated by capacitor C52 and resistor R53 so that a negative pulse is applied to the base of Q8 at the leading edge of the waveform followed by a positive trigger at the trailing edge. Pulse amplifier Q8 is biased on by the voltage divider of R54 and R55, and capacitor C53 provides for fast response to transient inputs. The output of Q8 (1D) consists of a positive pulse followed by a sharper negative pulse that triggers the delay multivibrator.

3.2.3 External Trigger Amplifier

Current switching drive for the trigger multivibrator is provided by the external trigger amplifier in the external and line voltage triggering modes. The basic circuit is a differential amplifier comprised of transistors Q5 and Q6 and diodes CR30 through CR33 as shown in the simplified schematic of Figure 3-5. Coupling capacitors C31 and C32 remove any dc component in the input signal, and triggering level potentiometer R36 is used to bias Q5 on or off as required by the polarity of the trigger input.

When repetition rate switch S1 is in the positive position (either line or external trigger slope) and Q5 is b

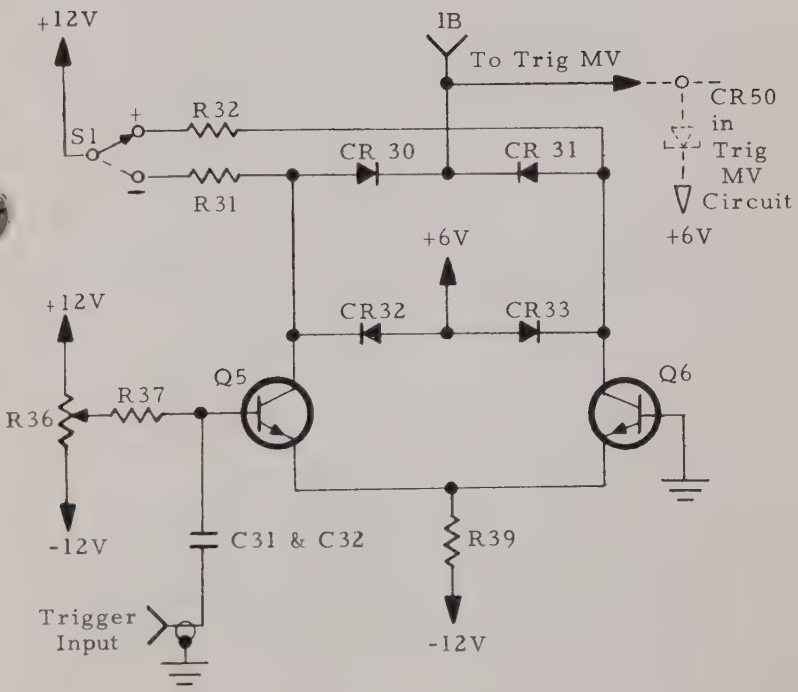


Figure 3-5. External Trigger Amplifier.

off by the setting of R36, Q6 is on. No current can flow to the trigger multivibrator circuit and tunnel diode CR50 is in its low voltage state because CR31 is back biased by these control settings; the cathode of CR50 is at +6 volts and when Q6 conducts its collector is clamped to +6 volts less the forward drop in CR33. The emitter of Q5 is held slightly below ground by the base-to-emitter drop in Q6, and Q5 is turned on by a positive trigger input that overcomes the bias at its base. This turns Q6 off and CR50 is driven to its high voltage state by current from the +12 volt supply through R32 and CR31. When the input signal subsides, Q5 turns off, Q6 turns on, and CR50 returns to its low voltage state until the next trigger turns Q5 on again.

When S1 is switched to its negative position with Q5 biased off by the setting of R36, CR50 is driven to its high voltage state by current from the +12 volt supply through R31 and CR30. For negative external triggering, R36 must be adjusted until Q5 just turns on and drives CR50 to its low voltage state by back biasing CR30. Negative triggers drive CR50 to its high state in this case by turning Q5 off, rather than on, as in positive triggering.

3.2.4 Gating Circuit

Gate control of the main pulse output is provided by the circuit consisting of external gate amplifier Q1, gate mode switch S2, and gate emitter follower Q9 in the schematic diagram. The normally continuous pulse output is turned off when switch S2 is in either gate position and occurs only during the pulse interval of an applied gate signal. The rate oscillator is gated in the synchronous mode and the delay multivibrator is gated in the asynchronous mode.

External gate amplifier Q1 operates as a switch that is normally off and is turned on by gate pulses applied to its base. In synchronous gating, switch S1 connects the output (collector) of Q1 to the base of Q3 through resistor R7 and to the base of Q4 through R4 and diode CR1. Current from the +12 volt supply through R3, R4, CR1, and CR3 keeps Q4 biased on so that the rate oscillator is turned off in the absence of a gate pulse. A positive going gate pulse, applied to its base, turns Q1 on and the resulting negative transient at its collector is applied to the base of emitter follower Q3

This is transferred through a timing capacitor to the base of Q4 and starts the rate oscillator by turning Q4 off. Oscillations continue until the gate pulse subsides and Q4 is biased on again by the forward drop in CR3.

In the asynchronous mode, the rate oscillator and the trigger multivibrator operate continuously, and the collector of Q1 is connected to the base of gate emitter follower Q9. Current from the +12 volt supply through R3, R50, and R51 to the -12 volt supply turns Q9 on by applying a positive bias to its base. Emitter current in Q9 produces a voltage drop in R58 and back biases diodes CR49 and CR51. The positive voltage on the diodes is greater than the negative swing of the multivibrator, and its output is inhibited until Q9 is turned off by a gate pulse. Thus the AND function is implemented in this gating mode so that the output pulses occur only when trigger pulses and the gate pulse are concurrent.

3.2.5 Delay Multivibrator

Pulse delay is determined by the variable RC time constant in the one-shot multivibrator of Figure 3-6. Both transistors are turned off by a negative trigger pulse from the AND gate and remain in this unstable condition until C_T discharges through R71 to restore Q10 and Q11 to their stable on state. Values of timing capacitor C_T are selected by delay range switch S70 and variable resistor R71 is the range calibration adjustment. Potentiometer R75 provides vernier control for each range by setting the voltage level of the charge on C_T.

Q10 is quiescently on between pulses because its emitter would go to +12 volts if it were off, and this is prevented by the negative bias applied to its base by the voltage drop in R74 and R75. Collector current in Q10 applies a positive bias to the base of Q11 and drives it into saturation. Both the collector and base of Q11 are near ground and diode CR70 is forward biased due to the low saturation junction voltages of Q11. This puts the collector of Q10 near ground with its base slightly positive with respect to its collector because of the forward voltage of CR70. Therefore, Q10 is fully on with its emitter slightly positive with respect to its base by its base-to-emitter junction voltage, and the charge on C_T is very low between pulses.

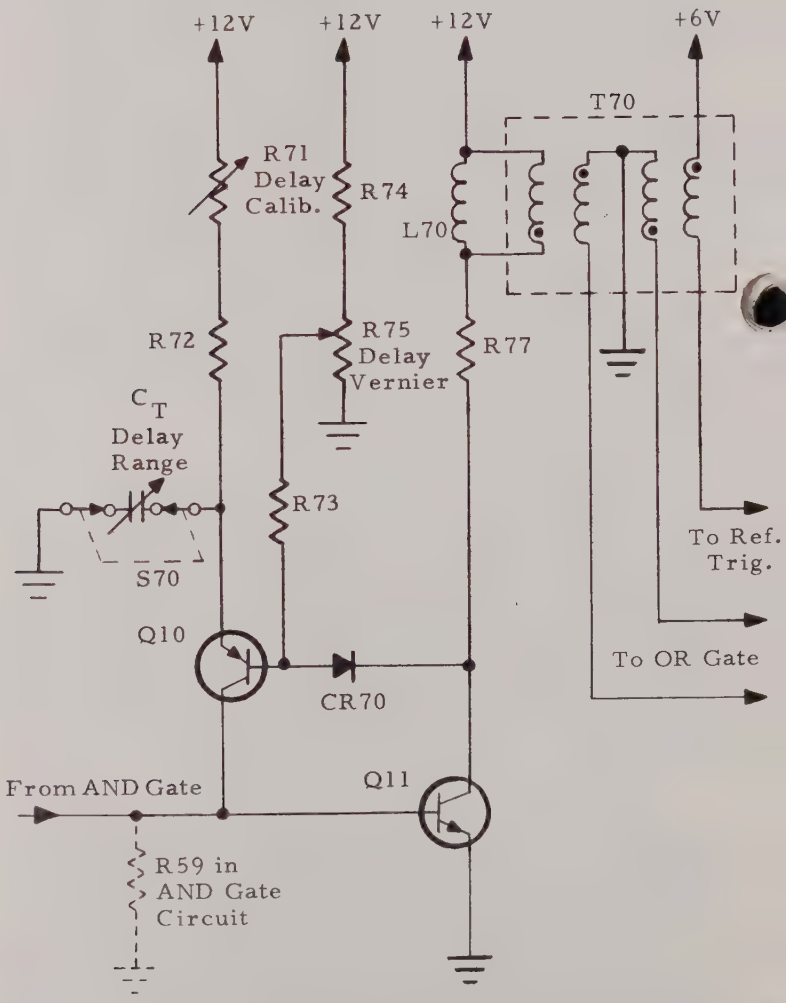


Figure 3-6. Delay Multivibrator.

Q11 is turned off by a negative trigger pulse at its base (from the trigger multivibrator through the AND gate) and CR70 is back biased by the sharp positive swing at the collector of Q11. Q10 turns off because its base voltage jumps from near ground to the positive setting of R75 when CR70 is back biased. C_T charges exponentially toward +12 volts through R71, and when its voltage becomes positive with respect to the setting of R75, Q10 turns on again. This turns Q11 on and the circuit is regeneratively restored to its quiescent state until the next negative trigger occurs.

Sharp output trigger pulses for the width multivibrator and the reference trigger output are obtained from pulse transformer T70. Two negative trigger pulses are supplied to the width multivibrator through the OR gate by separate windings of opposite polarity; one pulse occurs when Q11 turns off at the beginning of the delay interval and the other at the end when Q11 turns on again. Inductor L70 sharpens the transient applied to T70 by the voltage swing at the collector of Q11.

3.2.6 Trigger Outputs

Two trigger outputs are provided. The reference trigger is taken from the delay multivibrator and is synchronized with either the internal rate oscillator or the external trigger source. The auxiliary advance trigger is taken from the rate oscillator and does not occur during external, line slope, or manual triggering when the rate oscillator is off. Both triggers are gated in the synchronous mode; only the reference trigger is gated in the asynchronous mode and the advance trigger output is continuous.

Advance trigger amplifier Q7 in the schematic diagram is driven by the rectangular pulse at the collector of Q4 when the rate oscillator is on. The negative going leading edge of the pulse is inverted by Q7 and differentiated by emitter bypass capacitor C55 to produce sharp positive pulses at the collector of Q7. Resistor R62 provides 50 ohms source termination for the trigger output.

Negative trigger pulses that occur at the beginning of the delay interval are applied to the base of reference trigger amplifier Q12 by pulse transformer T70. Amplified

positive versions of these pulses appear at the collector of Q12 and are applied to the output by 50 ohm source resistor R81. Diode CR71 clamps the emitter of Q12 to +6 volts and prevents it from responding to positive excursions of the input at its base. The triggers are counted down when the delay interval is greater than the clock pulse period.

3.2.7 Width Multivibrator

Transistors Q13 and Q14 and their related circuit components in the schematic diagram comprise the width multivibrator circuit which is identical to the delay one-shot multivibrator. Q13 and Q14, like Q10 and Q11 in the delay circuits, are quiescently on. Pulse width is determined by the time required for the transistors to return to this stable on state after being turned off by a negative trigger pulse from the OR gate. Timing capacitors C90 through C95 are selected by width range switch S90, variable resistor R91 is the range calibration adjustment, and potentiometer R95 provides vernier control of each range.

Negative trigger pulses occurring at the beginning and at the end of the pulse delay interval are applied to diodes CR72 and CR73 in the OR gate circuit. Pulse mode switch S71 disconnects the first pulse from CR73 in the single position so that the width one-shot multivibrator is triggered only at the end of the delay interval. In the double pulse mode, the width circuit is triggered twice during each clock period to produce two identical pulses separated by the delay interval. The positive output pulse at the collector of Q14 is dc coupled to the base of Q15 in the output driver circuit.

3.2.8 Output Drivers and Amplifiers

Transistors Q15 through Q18 in the simplified schematic of Figure 3-7 are the output drivers and Q19 through Q22 are the output amplifiers. The negative output amplifier circuit is a mirror image of the positive amplifier with PNP, rather than NPN transistors and is not shown. The drivers are overdriven amplifiers and the output amplifiers are emitter followers.

Between pulses, Q15 is on with its base slightly above ground because it is dc coupled to the collector of Q14

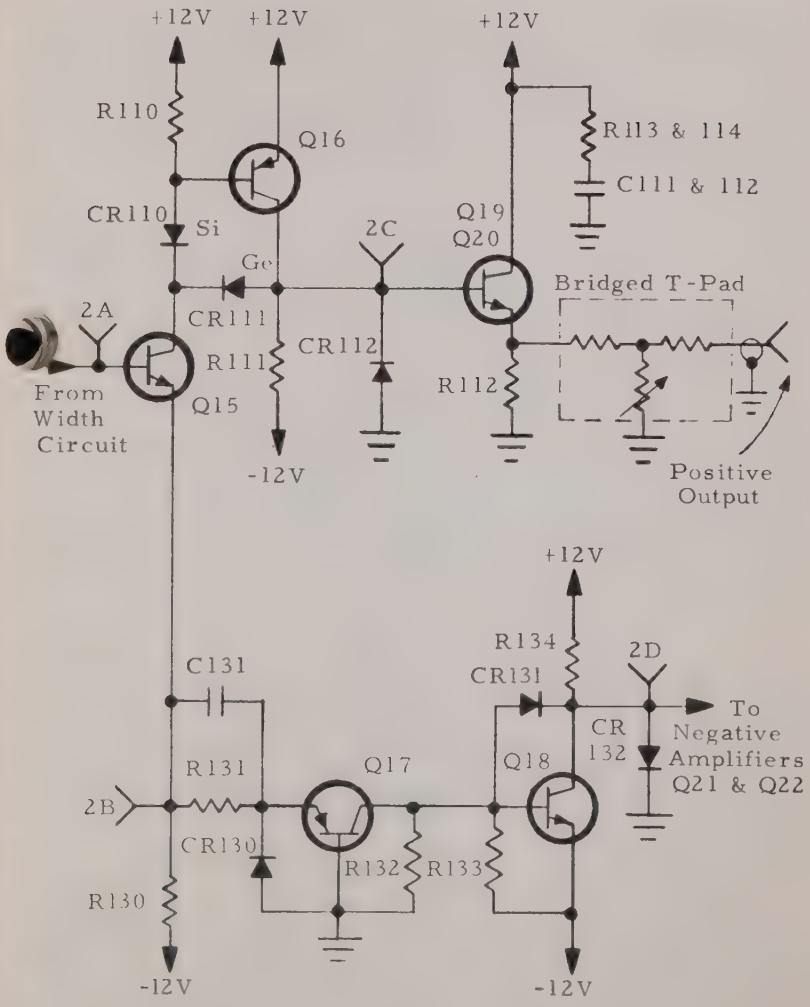


Figure 3-7. Output Drivers and Amplifiers.

in the width circuit, and Q14 is quiescently on with its emitter grounded. Q16 is near cutoff because collector current in Q15 is insufficient to forward bias its base by the voltage drop in R110. Current through CR112 and R111 to the -12 volt supply back biases CR111 and holds the collector of Q16 slightly below ground by the forward drop in CR112. Positive output amplifiers Q19 and Q20 are biased off by this slightly negative voltage at their base.

The near vertical leading edge of the positive pulse applied to its base produces a sudden negative swing at the collector of Q15 and drives Q16 to the threshold of saturation. The collector of Q16 rises sharply towards +12 volts but is restrained by the Baker clamp of CR110 and CR111; it locks to the difference between the cut-in voltage of silicon diode CR110 and the lower cut-in voltage of germanium diode CR111. At the edge of saturation, the gain of Q16 is greatly reduced, pulse top aberrations are attenuated and stored charge effects normally experienced in saturation are avoided. CR112 is back biased by the positive voltage at the collector of Q16, and Q16 remains on until abruptly turned off by the trailing edge of the applied pulse. Baseline undershoot and aberrations are sliced off between pulses when the collector of Q16 is driven to the slightly negative voltage of CR112.

The output at the emitters of Q19 and Q20 is a replica of the sharply defined rectangular pulse applied to their bases with its power level increased to meet the output requirements. The filter network of R113, R114, C111, and C112 decouples the output from the power supply to eliminate switching noise effects. The bridged-T attenuator provides a continuously variable output with a constant 50 ohms source impedance.

Input for the negative output driver is taken from the emitter of Q15 which is near ground between pulses. Current through CR130, R131, and R130 to the -12 volt supply back biases Q17 by the forward drop in CR130. The voltage divider of R132 and R133 holds the collector of Q17 and the base of Q18 near -12 volts. Q18 is near cutoff because the voltage drop in R133 is insufficient to forward bias its base. The collector of Q18 is slightly above ground, CR131 is back biased, and output amplifiers Q21 and Q22 are biased off by the forward drop of CR132.

Emitter current in Q15 through R130 applies an abrupt positive voltage swing to the emitter of Q17 when Q15 is turned on hard by the pulse from the width circuit. Q17 conducts heavily through R133 and turns Q18 on by driving its base positive with respect to its emitter. The collector of Q18 goes sharply negative but is restrained at the threshold of saturation by the base-to-collector clamp voltage of CR131. CR132 is back biased and the output amplifiers are turned on during the pulse interval. Q21 and Q22 are turned off by the trailing edge of the applied pulse and baseline aberrations are sliced off by the slightly positive voltage of CR132. The negative output is an inverted replica of the positive output with a separate attenuator for continuously variable amplitude control.

The circuit comprised of R112, C113, and CR113 through CR115 (not shown in the simplified schematic) eliminates negative overshoot in the positive output. C113 charges to approximately 1.4 volts (forward voltage of CR113 and CR114) during the pulse interval. CR115 is forward biased between pulses and C113 supplies positive current to cancel out negative overshoot. A mirror image circuit eliminates positive overshoot from the negative output.

3.2.9 Power Supply and Overload Protection

Positive and negative dc voltages for the instrument are provided by two mirror image series regulator circuits supplied by a single bridge rectifier as shown in the Power Supply schematic diagram. Power transformer T501 has two primary windings that are connected either in series by selector switch S501 for operation from 230 volt inputs or parallel for 115 volt inputs. Regulated +6 volts is obtained from the +12 volt supply by zener diode CR507 and emitter follower Q27.

Zener diode CR505 is connected between the output of the +12 volt supply and the base of error amplifier Q25 to provide the reference voltage for this supply. Any change in the output voltage produces an error signal that is amplified by Q25 and applied to the base of series regulator Q23. The response of Q23 to this input is a change in its collector-to-emitter voltage that is equal and opposite to the output voltage error. The high gain and fast response of this feedback

control circuit restricts the output voltage to minor fluctuations in spite of substantial changes in line voltage and load current.

Overload currents in the +12 volt supply increase the voltage drop in series resistor R515 until the base of current limiter Q28 is forward biased. This turns Q28 on and prevents excessive currents because the base of Q23 is back biased when Q28 conducts.

The regulator circuit for the -12 volt supply is identical to the +12 volt regulator except that it is composed of PNP rather than NPN transistors. Capacitors C501 through C513 are filters.

SECTION IV

MAINTENANCE

4.1 Preventive Maintenance

Proper care and correct use with regularly scheduled inspections provide the best protection against unnecessary repairs and down time. The Datapulse Model 101 is a sensitive laboratory instrument and should not be exposed to severe environmental conditions either in use or in storage. Contaminating or damaging exposure must be avoided at all times if long life and uninterrupted service are expected.

4.1.1 Inspection

Inspection intervals should be based on frequency of use and the severity of the environment to which the unit is exposed. Remove the top and bottom dust covers by loosening the four quarter-turn fasteners on each cover. The perforated side panels held on by self-tapping screws should normally not be removed. Inspect for dirt and corrosion and for loose, broken, or burnt parts and wiring. Circuit board discoloration caused by heat may usually be disregarded unless the unit is inoperative.

4.1.2 Cleaning

Accumulated dust and dirt should be removed as often as required. Use either low velocity dry air or a soft nonmetallic brush to clear the interior of foreign matter. Clean dirty parts with a solvent such as trichlorethylene or MEK (methyl ethyl ketone) using a soft cloth, or a cotton tipped applicator for narrow spaces. After cleaning, a small amount of lubriplate should be applied to the ball bearing in the detent plates of the front panel rotary switches.

4.1.3 Recalibration

The instrument is correctly calibrated when it leaves the factory. However, calibration should be checked at regularly scheduled intervals of either accumulated operating hours or calendar time; 500 operating hours or six-

month intervals are recommended. Refer to paragraph 4.4 for complete calibration instructions.

4.2 Parts Removal

A procedure should be carefully thought out before a part is removed to avoid unnecessary disassembly and accidental damage. Refer to the parts list (Section V) and use only direct replacements for parts affecting performance. Transistors temporarily removed should be returned to their original sockets unless defective. Replacement of some parts will necessitate recalibration.

4.2.1 Power Transistors

The power transistors for the dc power supply are mounted on the back panel under a cover plate. Fiber bushings and mica washers are used to electrically insulate the case (collector) of the transistors from the panel (chassis ground) and a thin film of silicon grease (such as Dow Corning DC-4) is applied to both sides of the mica washers to insure proper thermal conductivity. Incorrectly installed, the transistors may either short out or overheat and fail.

4.2.2 Selected Components

In some cases the value of a component is selected in production to avoid the use of a calibration adjustment. These components are marked with an asterisk on the schematic diagram, and it should not be necessary to alter their values throughout the life of the instrument. If replacement of a damaged part does not restore proper operation of the instrument, the factory or nearest Datapulse representative should be contacted for assistance.

4.2.3 Soldering

Only experienced technicians should replace soldered parts because printed circuits are vulnerable to excess heat as are many diodes and transistors. The following recommendations should be taken into consideration when replacing soldered parts:

a. Use small diameter rosin core solder and a 35 to 40 watt iron with a wedge or pointed tip, 1/16 to 1/8 inch wide. The tip must be clean and properly tinned with excess solder removed.

b. Obviously defective parts may be clipped out so their leads can be conveniently unsoldered from the board.

c. Solder only on the circuit side of the board; not on the component side.

d. Apply the tip of the iron directly to the solder joint, at the eyelet, just long enough for the solder to flow.

e. Avoid bringing the iron into contact with the circuit board; overheating will cause the conductor to lift from the board.

f. Use a solder sipper (or some other means) to remove excess solder first when unsoldering a lead, particularly where a lead is bent over so it can be straightened before it is pulled out.

g. When a lead is free, clean the hole and remove excess solder, using a solder sipper or a sharp object such as a toothpick or pointed tool.

h. To prevent heat damage when soldering heat sensitive components, use a heat sink or long nose pliers to grip the lead between the part and the board.

i. Leave a small space between the circuit board and the part when soldering heat dissipating components such as resistors.

j. Clean the area thoroughly after soldering.

4.3 Troubleshooting

Before concluding that an instrument is in need of repair, be sure it is being operated correctly and that it is

not out of calibration. Check for faulty operation by following the steps of paragraph 2.3 and use the procedure in paragraph 4.4 to verify calibration. A replaced or aging component may cause an apparent malfunction that is readily corrected by a calibration adjustment. Test equipment and connectors are frequent sources of trouble and should be double checked before deciding that the instrument is at fault. Refer to Table 4-1 for troubleshooting suggestions.

When neither the instrument nor its pilot lamp will go on the trouble is probably in the input power circuit. A unit that is operating incorrectly and is clearly in need of maintenance should be thoroughly inspected for obvious or apparent damage before its circuits are checked. The power supply, which is usually all right when its quiescent output and ripple voltages are correct, should be checked before the pulse forming circuits are suspected. To locate components on the circuit board, refer to Figure 4-1 (Parts Location).

4.3.1 Input Power Circuit

A general purpose volt-ohmmeter is needed for the following checks:

a. Make sure the line cord is correctly connected and making contact with the power source connector.

b. Remove the fuse from the back panel and check it for continuity. Replace the fuse.

c. Check the position of the 115/230 volt selector switch on the back panel.

d. Measure the line voltage at the source and check it for agreement with the setting of the 115/230 voltage selector switch.

e. Remove the top cover and check for line voltage between points BA and BR in the right rear corner of the circuit board.

NOTE: Refer to the Power Supply schematic for the circuit location of test points and to Figure 4-1 for the physical location.

Figure 4-1. Parts Location - Model 101

TROUBLE	CHECK
1. Instrument and pilot lamp won't go on when the POWER switch is turned ON.	1. Check the input power circuit. a. Verify line voltage (115) at the source. b. Verify line voltage at the junction box. c. Check the 115/230 slide switch position. d. Check the fuse for continuity. e. Verify line voltage between BR and BC, and BR and BE.
2. Pilot lamp lights dimly.	2. Check the 115/230 slide switch position.
3. Pilot lamp lights but instrument does not operate.	3. Check the power supply circuit. a. Check the +12 to +14, +5 to +6.5, and -12 to -14 volt dc outputs. b. Verify 40 to 44 volts dc between BJ and BM (at 117 volts ac input). c. Verify 36 to 40 volts ac between BG and BH (at 117 volts ac input).
4. Fuse blows when unit is turned on.	4. Check for shorted rectifiers (CR501 through CR504) or shorted filter capacitors (C501 and C502).
5. Unregulated dc voltage too low (BJ to BM).	5. Check for open rectifier (CR501 through CR504).
6. +12 to +14 and +5 to +6.5 volt dc outputs too high.	6. Check positive regulator circuit. a. Check for shorted Zener (CR505). b. Check for burnt 4.7 ohm resistor (R512 through R514). c. Check regulation (vary line voltage + and - 10%).
7. -12 to -14 volt dc output too high.	7. Check negative regulator circuit. a. Check for shorted zener (CR506). b. Check regulation (vary line voltage).
8. +12 to +14 volt dc output too low.	8. Check series regulator Q23.
9. -12 to -14 volt dc output too low.	9. Check series regulator Q24.
10. Positive dc output does not regulate.	10. Check error amplifier Q25.
11. Negative dc output does not regulate.	11. Check error amplifier Q26.
12. +5 to +6.5 dc output too low but +12 to +14 dc output all right.	12. Check emitter follower Q27 and zener CR507.
13. Q23 fails when positive output is shorted.	13. Check current limiter Q28.
14. Q24 fails when negative output is shorted.	14. Check current limiter Q29.
15. 4.7 ohm resistor (R512 through R514) burnt.	15. Check for shorted positive dc output. a. Check triggering level control R36
16. Positive output baseline above ground.	16. Check for shorted output transistor (Q19 and Q20). Also check positive dc output.
17. Negative output baseline below ground.	17. Check for shorted output transistor (Q21 and Q22). Also check negative dc output.
18. Positive output pulse aberration too high.	18. Check for open output transistor (Q19 and Q20).
19. Negative output pulse aberration too high.	19. Check for open output transistor (Q21 and Q22).
20. No positive output but negative output all right.	*20. Check waveform at 2C. a. If all right, check circuit between 2C and output jack. b. If not all right, check circuit between 2B and 2C.
21. No negative output but positive output all right.	*21. Check waveform at 2D. a. If all right, check circuit between 2D and output jack. b. If not all right, check circuit between 2B and 2D.
22. Both main outputs absent but both trigger outputs all right.	*22. Check waveforms at 2B, 2A, and 1E. a. When 2A but not 2B is all right, check circuit of Q15. b. Check width circuit (Q13, Q14, and S90) when 1E, but not 2A, is all right.
23. Both main outputs and reference trigger absent but advance trigger all right.	*23. Check the waveforms at 1B and 1D. a. Check tunnel diode CR50 if 1B is not correct. b. Check the circuit of Q8 if 1B is all right but not 1D. c. Check the delay circuit (Q10, Q11, and S70) if 1D is all right.
24. Both main outputs and both trigger outputs absent.	*24. Check the waveform at 1C. a. If 1C is all right, check Q7 and make the checks of step 23. b. If 1C is not correct, check the waveform at P (base of Q4). c. Check the rate oscillator (Q2, Q3, Q4, S1, and S2) if the waveform at P is not correct.

*Check waveforms by comparing the actual test point waveform to the corresponding waveform of Figure 3-2, using the control settings given for Figure 3-2.

Table 4-1. Troubleshooting

f. Check for line voltage between points BC and BR (this includes the fuse circuit).

g. Verify line voltage between points BE and BR with the POWER switch ON.

h. Measure the transformer secondary voltage between points BG and BH on the left side of the transformer. It should be approximately 38 volts ac at nominal line voltage.

4.3.2 Power Supply

The REPETITION RATE selector must be in the SINGLE PULSE position and the POWER switch must be ON for the following checks:

a. Measure the dc voltages (+12, +6, and -12). The voltage points are labeled on the top of the circuit board near the back and the values are referenced to chassis ground.

b. Use an oscilloscope (or any other suitable means) to measure the quiescent ripple voltage (with REPETITION RATE selector in the SINGLE PULSE position) of the three dc outputs. It is typically 2 millivolts peak-to-peak for all three dc outputs.

c. Measure the unregulated output of the bridge rectifier between points BJ and BM. It should be approximately 42 volts dc at nominal line voltage.

NOTE: The ripple voltage is much higher when the power supply is under load.

d. Check the dc voltages under load by setting the 101 controls as follows: REPETITION RATE controls: 1.0 MHz; PULSE WIDTH controls: 0.5 μs; AMPLITUDE controls: minimum; GATE MODE switch: NON-GATED; PULSE MODE switch: SGL; and the remaining controls to any position. Verify that the dc voltages do not change noticeably from the values measured in step b.

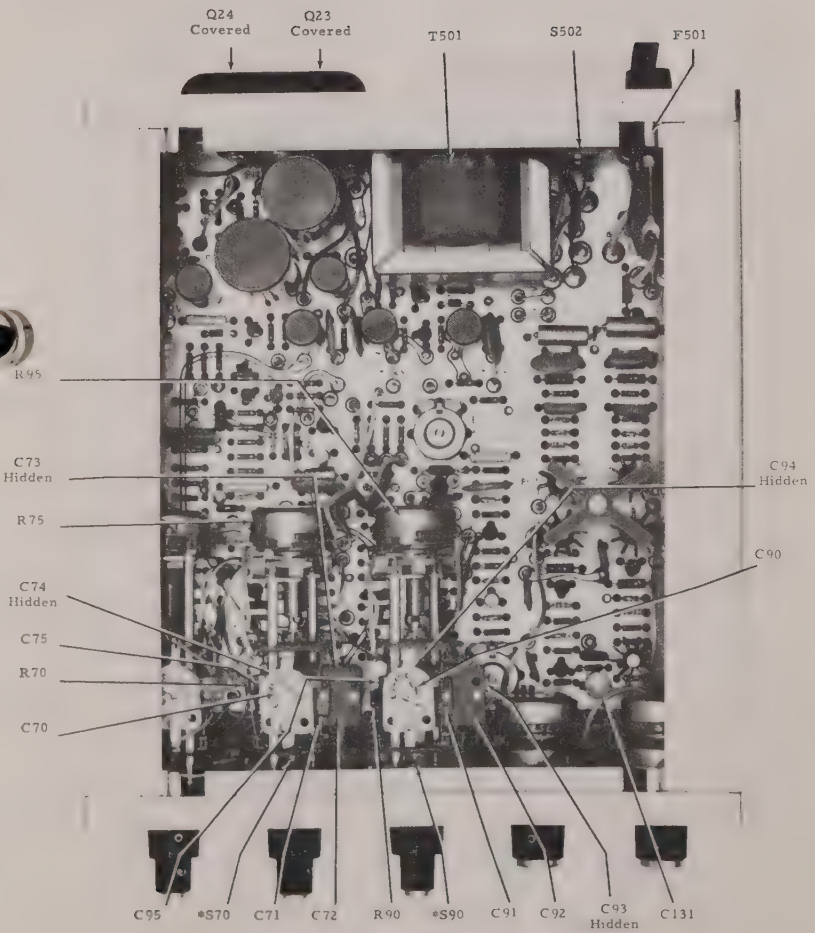
NOTE: Many power supply failures are caused by collector-to-emitter shorts in transistors and anode-to-cathode shorts in rectifiers and zener diodes. A shorted semiconductor will exhibit low resistance in both directions.

4.3.3 Pulse Circuits

After verifying that the power supply is operating correctly, the remaining circuits should be inspected again for visual damage that may have been overlooked. However, it should not be assumed that a problem is solved when an obviously defective part is replaced because its failure may be the result of a more basic cause. An operational check (paragraph 2.3) will sometimes give an indication of where to look for the trouble. Calibration adjustments (paragraph 4.4) should be double checked before a circuit is condemned. The theory of operation (Section III) and the schematic diagram should be studied first to gain a thorough understanding of the operation of the instrument before an attempt is made to troubleshoot any of its circuits. Refer to Figures 4-1 through 4-3 for the location of circuit components and test points.

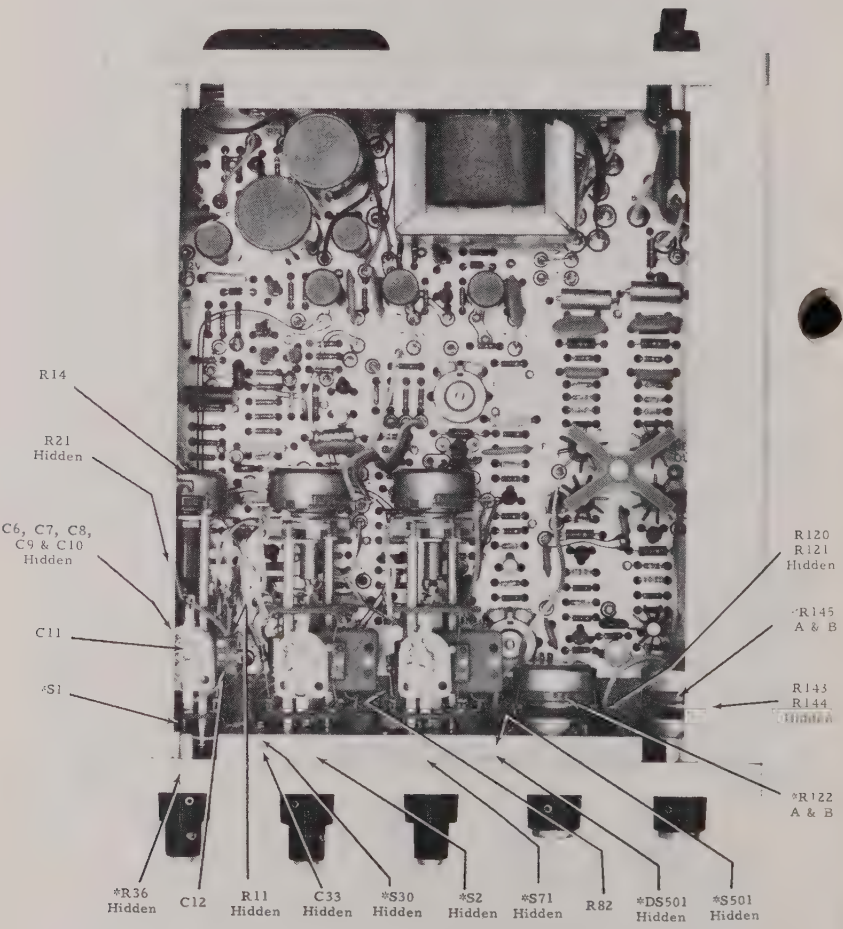
Excessive pulse aberration in the output indicates that one output transistor (Q19 and Q20 or Q21 and Q22) is open. If, on the otherhand, an output transistor is shorted, the pulse baseline will shift above ground for the positive output, or below for the negative. However, the power supply should also be checked if the baseline is off ground because a dc voltage that is too high produces the same effect. One output transistor may be shorted while the other is open but this becomes apparent when they are replaced one at a time.

When there is no pulse at the main output, the best way to locate the trouble is to compare the actual test point waveforms to the waveforms of Figure 3-2 (be sure the control settings are the same as those given for Figure 3-2). Check the other main output first, and if it is satisfactory the trouble is probably in the output driver and amplifier circuit (between test point 2B and the absent output). Monitor 2C when the positive output is missing, or 2D when there is positive but no negative output, to determine whether the



* Mounted on front panel.

Figure 4-2a. Top View - Model 101



* Mounted on front panel.

Figure 4-2b. Top View - Model 101

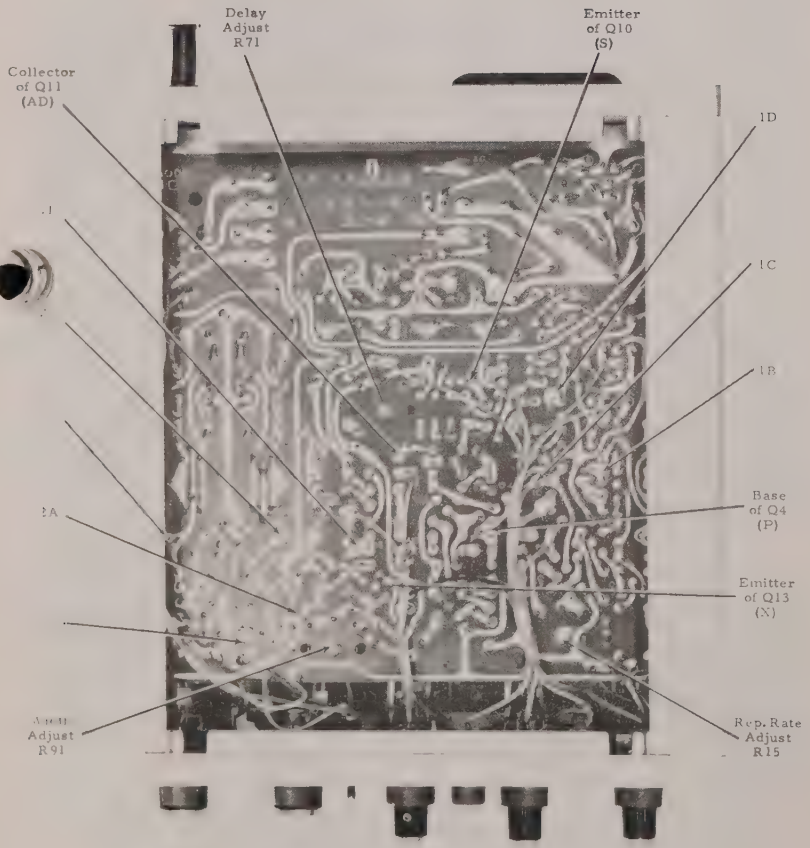


Figure 4-3. Bottom View - Model 101

trouble is in the driver (Q15 and Q16 or Q17 and Q18) or the amplifier (Q19 and Q20 or Q21 and Q22) circuit.

Check the trigger outputs when both main outputs are absent and if both are present, monitor test points 2A, 2B, and 1E in turn. Suspect Q15 when the waveform is correct at 2A but not at 2B. Look for trouble in the width circuit (Q13, Q14, and S90) when the waveform is all right at 1E but not at 2A. A bad waveform at 1E indicates that the problem is in the circuit between pulse transformer T70 and test point 1E.

Tunnel diode CR50 is the most likely offender if all outputs except the advance trigger are absent, and it can be checked at 1B. Troubleshoot the delay circuit (Q10, Q11, and S70) if the trigger multivibrator waveforms (1B and 1D) and the advance trigger are all right. When all outputs are absent, check the waveforms at the base of Q4 (test point P) and if it is unsatisfactory, look for trouble in the rate oscillator circuit (Q2 through Q4 and S1); also check the gate mode switch (S2) circuit.

The absence of a trigger output, when the main outputs are satisfactory, should be attributed to Q7 if the advance trigger is missing, or to the circuit of Q12 if there is no reference trigger. When a unit operates correctly but cannot be triggered from an external source, troubleshoot the external trigger amplifier circuit (Q5, Q6, and S1). Check the circuit containing Q1, Q9, and S2 for gating circuit problems.

4.4 Calibration

Calibration adjustments should be made only when necessary and only when instruments with the required accuracies are available. Adjustments are limited to the accuracies of the calibrating instruments which are typically ±3% for most oscilloscopes and general purpose voltmeters. Power supply voltages should be checked before any adjustment is made on an instrument that appears to be out of calibration. It will normally not be necessary to follow the sequence of this procedure and individual adjustments may be made when necessary. However, interaction between the calibration potentiometer and trimmer capacitor in the repetition rate, delay, and width circuits makes it necessary to adjust the potentiometer first.

The seven calibration controls are accessible when the top and bottom covers are removed by loosening the four quarter-turn fasteners on each cover. The three potentiometers in the repetition rate, delay, and width circuits are adjusted from the bottom by a small screwdriver. An insulated screwdriver should be used on the four trimmer capacitors (in the repetition rate, delay, width, and driver circuits) which are accessible from the top. Refer to Figures 4-2 and 4-3 for location of calibration controls.

4.4.1 Equipment (or equivalent) Required

a. A multiple range ac-dc voltmeter with an accuracy of 3% such as a volt-ohmmeter.

b. A general purpose oscilloscope of at least 15 megahertz bandpass with triggered sweep and a dual trace amplifier.

c. A sampling oscilloscope with a rise time of 0.4 nanoseconds and a dual trace amplifier.

d. Two 50 ohm coaxial attenuators (a 20:1 and a 10:1) capable of 2 watts dissipation.

NOTE: Standard one watt attenuators are adequate in most cases but should be used with care because pulse output power will approach 2 watts for high duty cycle waveforms at full amplitude.

e. A 50 ohm coaxial termination capable of 2 watts dissipation (see note for step d) such as a Datapulse 2003A Power Termination.

f. A 50 ohm coaxial termination capable of 1/2 watt dissipation.

g. Two (or more) 50 ohm coaxial cables with BNC connectors and a BNC Tee connector.

4.4.2 Power Supply Check

WARNING

Check the position of the 115/230 volt selector switch (near the line cord on the back) for the correct voltage before connecting the cord.

a. Connect the instrument to a suitable power source and turn the POWER switch ON.

b. Remove the top cover by turning the four quick-release fasteners one-quarter turn.

c. Check the ac line voltage between points BA and BR on the right rear corner of the circuit board. It should be between 105 and 125 or 210 and 250 volts.

d. Turn the REPETITION RATE selector to the SINGLE PULSE position and check the dc voltages for the indicated tolerances. The voltage points are labeled on the top of the circuit board near the back.

1. +12 volts to +14 volts dc

2. +5 volts to +6.5 volts dc

3. -12 volts to -14 volts dc

4.4.3 Repetition Rate Calibration

The calibration potentiometer for the rate oscillator (R15 on the schematic diagram) is on the left front corner of the circuit board and the trimmer capacitor (C11) is mounted on top of the repetition rate switch assembly.

a. Remove the bottom cover by turning the four quick-release fasteners one-quarter turn.

b. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	1.0 MHz
REPETITION RATE vernier	fully clockwise
PULSE WIDTH selector	0.1 μs
PULSE WIDTH vernier	fully clockwise
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL
Remaining controls	any position

c. Connect the 2 watt, 50 ohm, coaxial termination to the POS OUTPUT jack using a 50 ohm coaxial cable.

d. Monitor the POS OUTPUT at the terminating load on the general purpose oscilloscope. Synchronize the oscilloscope to the ADVANCED TRIGGER OUTPUT and adjust the POSITIVE AMPLITUDE for a convenient display.

e. Verify that the repetition rate is 1.0 megahertz (1.0 microsecond period). If it is not, adjust R15 as required.

NOTE: The oscilloscope may be used for this adjustment providing its accuracy is acceptable. The instrument should be adjusted to the repetition rate indicated on the front panel by the selector switch (in this case 1.0 MHz) when the vernier is fully clockwise.

f. Turn the REPETITION RATE vernier fully counterclockwise and verify that the frequency goes down to less than 0.1 megahertz. If it does not, repeat step e and recheck the adjustment of R15.

NOTE: Full frequency coverage requires that the ranges overlap. If the correct setting of R15 at the upper limit does not provide overlap at the lower limit, the oscillator circuit is malfunctional.

g. Set the REPETITION RATE selector to 10 MHz with its vernier fully clockwise and the PULSE WIDTH selector to 0.1μs with its vernier counterclockwise. Verify that the repetition rate is 10 megacycles (0.1 microsecond period). If it is not, adjust trimmer capacitor C11 as required.

h. Turn the REPETITION RATE vernier fully counterclockwise and verify that the frequency goes down to less than 1.0 megahertz. If it does not, recheck the adjustment of C11.

i. Check each of the remaining four ranges for front panel frequency at the upper limit and for overlap at the lower limit. A convenient pulse width setting is one-tenth the rate oscillator period. If full frequency coverage is not provided, return the instrument to the settings of step b and repeat steps e through h.

NOTE: If it is not possible to get full range coverage, one or more of the timing capacitors (C6 through C12) mounted on the repetition rate switch assembly may be out of tolerance.

4.4.4 Pulse Width Calibration

Width calibration potentiometer R91 is at the front of the circuit board near the pulse width switch assembly, and width trimmer capacitor C90 is on the switch assembly.

a. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	0.1 MHz
REPETITION RATE vernier	fully clockwise
PULSE WIDTH selector	1.0 μs
PULSE WIDTH vernier	fully clockwise
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL
Remaining controls	any position

b. Monitor the POS OUTPUT at the terminating load on the general purpose oscilloscope. Synchronize the oscilloscope to either TRIGGER OUTPUT and adjust the POSITIVE AMPLITUDE control for a convenient display.

c. Verify that the pulse width is 1.0 microsecond. If it is not, adjust potentiometer R91 as required.

NOTE: The 1000:1 coverage of pulse width and delay makes it unnecessary to check for overlap at the lower limit of each range.

d. Check the 10 μs, 0.1 MS, 1.0 MS, and 10 MS ranges for front panel width at the upper limit. A repetition rate with a period ten times the pulse width provides a convenient oscilloscope display.

e. Monitor the POS OUTPUT at the terminating load on the sampling oscilloscope through the 20:1 coaxial attenuator and synchronize the oscilloscope from either TRIGGER OUTPUT using the 10:1 coaxial attenuator if necessary.

NOTE: Most sampling oscilloscopes have a maximum input level of 250 millivolts and require that the main pulse and trigger outputs be adequately attenuated.

f. Set the PULSE WIDTH selector to 0.1 μs and the REPETITION RATE selector to 1.0 MHz with both verniers fully clockwise.

g. Verify that the pulse width is 0.1 microsecond. If it is not, adjust trimmer capacitor C90 as required.

h. Turn the vernier fully counterclockwise and note that the pulse width goes down to less than 30 nanoseconds. If it does not, turn the vernier fully clockwise and recheck the setting of C90.

4.4.5 Pulse Delay Calibration

Delay calibration potentiometer R71 is near the center of the circuit board labeled DEL (on top) and delay trimmer capacitor C70 is mounted on top of the pulse delay switch assembly.

a. Set the instrument controls as follows:

Control	Setting
REPETITION RATE selector	0.1 MHz
REPETITION RATE vernier	fully clockwise
PULSE DELAY selector	1.0 μs
PULSE DELAY vernier	fully clockwise
PULSE WIDTH selector	1.0 μs
PULSE WIDTH vernier	fully clockwise
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL
Remaining controls	any position

b. Connect the REFERENCE TRIGGER OUTPUT to the 1/2 watt, 50 ohm coaxial termination and monitor both the positive output and the reference trigger at their terminating loads on the general purpose oscilloscope with its dual trace amplifier.

c. Synchronize the oscilloscope to the REFERENCE TRIGGER OUTPUT and adjust the POSITIVE AMPLITUDE for a convenient display.

d. Verify that the output pulse is delayed 1.0 microsecond from the reference trigger. If it is not, adjust R71 as required.

e. Check the 10 μs, 0.1 MS, 1.0 MS, and 10 MS ranges for front panel delay at the upper limit. For a convenient oscilloscope display, set the width controls the same as the delay controls and the repetition rate for a period ten times the pulse width.

f. Monitor both the POS OUTPUT and the REFERENCE TRIGGER OUTPUT on the sampling oscilloscope with its dual trace amplifier, using the 20:1 attenuator for the main output and the 10:1 attenuator for the trigger.

g. Set the PULSE DELAY and PULSE WIDTH selectors to 0.1 μs and the REPETITION RATE selector to 1.0 MHz with their verniers fully clockwise.

h. Verify that the pulse delay is 0.1 microsecond. If it is not, adjust trimmer capacitor C70 as required.

i. Turn the vernier fully counterclockwise and note that the pulse delay goes down to less than 30 nanoseconds. If it does not, turn the vernier fully clockwise and recheck the adjustment of C70.

4.4.6 Output Driver Calibration

Trimmer capacitor C131 in the negative output driver circuit is mounted on the front of the circuit board between the two front panel amplitude controls.

a. Connect the 2 watt, 50 ohm termination to the NEG OUTPUT jack through a 50 ohm coaxial cable.

b. Monitor the NEG OUTPUT at the terminating load on the sampling oscilloscope and synchronize the oscilloscope to either TRIGGER OUTPUT using the 20:1 attenuator for the main output and the 10:1 attenuator for the trigger.

c. Set the instrument controls as follows:

Control	Setting
REPETITION RATE controls	5-10 MHz
PULSE WIDTH controls	minimum
GATE MODE switch	NON-GATED
PULSE MODE switch	SGL
Remaining controls	any position

d. Set the NEGATIVE AMPLITUDE for a convenient oscilloscope display and adjust trimmer capacitor C131 for the steepest rise time with the least amount of pulse distortion.

SECTION V

PARTS LIST

5.1 Abbreviations and Symbols

5.1.1 Reference Designations

Reference designations used are the assigned circuit symbols in the following schematic diagrams:

Drawing Number J40000-154

Drawing Number D40000-195

Resistors are designated as R1, R2, R3, etc., and are in ohms, fixed value, composition, 5%, and 1/4 watt unless otherwise noted.

Capacitors are designated as C1, C2, C3, etc., and are in picofarads, fixed value, dipped mica, 5% (except electrolytics), and 500 volts dc unless otherwise noted.

Transistors are designated as Q1, Q2, Q3, etc., and are silicon unless otherwise noted.

Diodes are designated as CR1, CR2, CR3; inductors as L1, L2, L3; switches as S1, S2, S3, etc.

5.1.2 Abbreviations

ampere	A
alternating current	ac
coefficient	Coef.
concentric	Conc.
direct current	dc
kilohm	k
manufacturer	MFR.
microfarad	µF
milliampere	mA
milliwatt	mW
negative-positive-negative	NPN
number	NO.

5.1.2 Abbreviations (continued)

microhenry	μH
electrolytic	Elect.
double-pole-double-throw	DPDT
position	Pos.
positive-negative-positive	PNP
quantity	QTY.
reference	REF.
section	Sec.
single-pole-double-throw	SPDT
temperature	Temp.
variable	Var.
volts	V
watts	W
wire wound	WW
silvered mica	SM
tantalum	Ta.
ceramic	Cer.
germanium	Ge.
transformer	Xfmr.

5.1.3 Manufacturers

Allen Bradley Company	AB
Bussman Manufacturing Company	Buss
Centralab	CRL
Chicago Telephone Supply	CTS
C & K Components	C&K
Continental-Wirt	C-W
Corning Glass Works	Corning
Datapulse Incorporated	DP
Diodes Incorporated	DI
Drake Manufacturing Company	Drake
Elco Corporation	Elco
Electro Motive Manufacturing Company	Elmenco
Erie Technological Products Incorporated	Erie
Fairchild Semiconductor Products Incorporated	FT
General Electric Company	GE
IMB Electronic Products	IMB
Littelfuse Incorporated	Littelfuse

5.1.3 Manufacturers (continued)

Magnetic Components Incorporated	MCI
Motorola Semiconductor Products Incorporated	Motorola
Nashville Electronics Incorporated	Whale
Oak Manufacturing Company	Oak
Radio Corporation of America	RCA
Radio Materials Company	RMC
Sangamo Electric Company	Sangamo
Semcor Division of Components Incorporated	Semcor
Sprague Electric Company	Sprague
Switchcraft Incorporated	Switch
Sylvania Electric Products Incorporated	Sylvania
Tennessee Electronics Incorporated	Whale
TRW Capacitor Division of TRW Incorporated	TRW
Wakefield Engineering Incorporated	WE
Wilco Corporation	Wilco

5.2 Repetition Rate Switch Assembly

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.2.1	Resistors				
R11	1	51	10010-510	AB	CB-5105
R14	1	Var., 10k, 2W, 10%	20043-103	AB	JA1N056S103BA
R21	1	100	10010-101	AB	CB-1015
5.2.2	Capacitors				
C6	1	8.2 μF, 20V, 10%, Ta.	11511-825	Sprague	150D825X 9020B2
C7	1	1 μF, 200V, 1%, Mylar	11124-105	IMB	ZA2C105F
C8	1	0.1 μF, 200V, 1%, Mylar	11124-104	IMB	ZA2C104F
C9	1	0.01μF, 300V, 1%, SM	11025-103	Sangamo	CRK3C103F
C10	1	820, 1%, SM	11027-821	Elmenco	CM20D821F
C11	1	Var., 7 to 45, Cer., Temp. Coef. N500	11307-450	Erie	503-000-33C
C12	1	33, SM	11017-330	Sangamo	DR5E330J
5.2.3	Switches				
S1	1	Rotary, 11 Pos., 2 Sec., Conc., 30° Throw, Shorting	25250-037	Oak	256741-J2

5.3 Pulse Delay Switch Assembly

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.3.1	Resistors				
R70	1	47	10010-470	AB	CB-4705
R75	1	Var., 10k, 2W, 10%	20053-103	AB	JA1N056S103UA
5.3.2	Capacitors				
C70	1	Var., 7 to 45, Cer., Temp. Coef. N500	11307-450	Erie	503-000-33C
C71	1	430, 1%, SM	11027-431	Sangamo	RR5E431F
C72	1	4700, 300V, 1%, SM	11025-472	Sangamo	CR3C472F
C73	1	0.047 μF, 100V, Mylar	11089-473	IMB	MA2B473J
C74	1	0.47 μF, 200V, 1%, Mylar	11124-474	IMB	ZA2C474F
C75	1	5 μF, 15V, Elect.	11151-505	Sprague	TE1152
5.3.3	Switches				
S70	1	Rotary, 6 Pos., 2 Sec., Conc., 45° Throw, Shorting	25250-033	Oak	245021-AF2

5.4 Pulse Width Switch Assembly

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.4.1	Resistors				
R90	1	47	10010-470	AB	CB-4705
R95	1	Var., 10k, 2W, 10%	20053-103	AB	JA1N056S103UA
5.4.2	Capacitors				
C90	1	Var., 7 to 45, Cer., Temp. Coef. N500	11307-450	Erie	503-000-33C
C91	1	430, 1%, SM	11027-431	Sangamo	RR5E431F
C92	1	4700, 300V, 1%, SM	11025-472	Sangamo	CR3C472F
C93	1	0.047 μF, 100V, Mylar	11089-473	IMB	MA2B473J
C94	1	0.47 μF, 200V, 1%, Mylar	11124-474	IMB	ZA2C474F
C95	1	5 μF, 15V, Elect.	11151-505	Sprague	TE1152
5.4.3	Switches				
S90	1	Rotary, 6 Pos., 2 Sec., Conc., 45° Throw, Shorting	25250-033	Oak	245021-AF2

Front Panel Assembly

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.5.1	Resistors				
R36	1	Var., 10k, 0.1W, 20%	10980-103	CRL	BA001-8/12
R82	1	470	10010-471	AB	CB-4715
R120	4	51, 2W	10723-510	Corning	RL42S510J
R121		Same as R120			
R122A, B	2	Var., 50, Dual Ganged, 2W, 20%	20213-500	AB	JJ88952A
R143		Same as R120			
R144		Same as R120			
R145A, B		Same as R122A, B			
5.5.2	Capacitors				
C33*	1	0.1 µF, 75V, Cer., +80%, -20%	11242-104	RMC	Type TA
5.5.3	Switches				
S2	1	Slide, Miniature 0.5A, 125V ac, DPDT	15310-001	C-W	G-128-S
S30	1	Pushbutton, 30W, 250 mA ac, SPDT, Red	15300-001	Sw.	903-1C-Red
S71	1	Slide, Miniature 0.5A, 125V ac, SPDT	15310-002	C-W	G-124

*Value is factory selected and may differ from the value given.

RFF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.5.3	Switches (continued)				
S501	1	Toggle, SPDT, 5A 115V ac	15280-001	C&K	7101
5.5.4	Miscellaneous				
DS 501	1	Indicator, Neon, NE2H, Red	15450-002	Drake	H116-323
5.6	**Back Panel Assembly**				
5.6.1	Transistors				
Q23	1	NPN	12675-007	RCA	40250
Q24	1	PNP, Ge.	12455-008	Motorola	2N1535
5.6.2	Switches				
S502	1	Slide, 6A ac, DPDT	15310-003	C-W	G326 Modified
5.6.3	Miscellaneous				
F501	1	Fuse, 1A, Slo-Blow, 250V	15470-030	Littelfuse	313001
T501	1	Power Xfmr.	24010-013	MCI	24010-013

Main Circuit Board Assembly

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.1	Resistors				
R1	2	3.9k	10010-392	AB	CB-3925
R2	11	1 k	10010-102	AB	CB-1025
R3		Same as R2			
R4		Same as R2			
R5	5	4.7k	10010-472	AB	CB-4725
R6	1	100k	10010-104	AB	CB-1045
R7	2	15k	10010-153	AB	CB-1535
R8	2	220	10010-221	AB	CB-2215
R9	3	51	10010-510	AB	CB-5105
R10		Same as R2			
R12	2	2.7k	10010-272	AB	CB-2725
R13*	2	22	10010-220	AB	CB-2205
R15	3	Var., 1 k, 0.2W,30%	20240-102	CTS	Series UPM-70
R16	6	200	10010-201	AB	CB-2015
R17		Same as R2			
R18		Same as R16			
R19	1	1.2k	10010-122	AB	CB-1225
R20	2	47	10010-470	AB	CB-4705
R30	4	10k	10010-103	AB	CB-1035
R31		Same as R2			
R32		Same as R2			
R33		Same as R30			

*Value is factory selected and may differ from the value given.

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.1		Resistors (continued)			
R34	7	100	10010-101	AB	CB-1015
R35		Same as R2			
R37		Same as R30			
R38	1	270	10010-271	AB	CB-2715
R39	8	1.5k	10010-152	AB	CB-1525
R40		Same as R34			
R41		Same as R7			
R42	1	2.2k	10010-222	AB	CB-2225
R50		Same as R39			
R51		Same as R30			
R52		Same as R34			
R53*	1	68	10010-680	AB	CB-6805
R54		Same as R2			
R55		Same as R39			
R56		Same as R12			
R57		Same as R39			
R58		Same as R8			
R59		Same as R5			
R60		Same as R2			
R61		Same as R1			
R62*		Same as R9			
R71		Same as R15			
R72		Same as R39			
R73	2	3.3k	10010-332	AB	CB-3325

*Value is factory selected and may differ from the value shown.

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.1		Resistors (continued)			
R74		Same as R5			
R76	4	470	10010-471	AB	CB-4715
R77	3	390	10010-391	AB	CB-3915
R78	1	150	10010-151	AB	CB-1515
R79		Same as R2			
R80		Same as R76			
R81		Same as R9			
R83		Same as R76			
R84		Same as R5			
R91		Same as R15			
R92		Same as R39			
R93		Same as R73			
R94		Same as R5			
R96	2	680	10010-681	AB	CB-6815
R97		Same as R34			
R110		Same as R13			
R111	2	560, 1/2W	10011-561	AB	EB-5615
R112		Same as R39			
R113	4	1, 1/2W	10011-109	AB	EB-10G5
R114		Same as R113			
R115	6	4.7	10010-479	AB	CB-47G5
R130	1	560	10010-561	AB	CB-5615
R131*		Same as R76			
R132	1	5.6k	10010-562	AB	CB-5625

*Value is factory selected and may differ from the value given.

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.1		Resistors (continued)			
R133		Same as R20			
R134		Same as R111			
R135		Same as R39			
R136		Same as R113			
R137		Same as R113			
R138		Same as R115			
R501	1	27k, 1/2W	10011-273	AB	EB-2735
R502		Same as R16			
R503		Same as R16			
R504		Same as R77			
R505		Same as R16			
R506		Same as R16			
R507		Same as R77			
R508		Same as R34			
R509		Same as R34			
R510		Same as R96			
R511		Same as R34			
R512		Same as R115			
R513		Same as R115			
R514		Same as R115			
R515	2	2.7	10010-279	AB	CB-27G5
R516		Same as R115			
R517		Same as R515			

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.2	Capacitors				
C1	1	0.01 μF, 100V, 10%, Mylar	11083-103	TRW	663UW10391
C2	1	10	11077-100	Sangamo	D155C100J03
C3*	1	6.8, 1000V, Cer.	11249-689	Sprague	10TCC-V68
C4	8	0.1 μF, 75V, +80%, -20%, Cer.	11242-104	RMC	Type TA
C5	1	10 μF, 15V, Elect.	11151-106	Sprague	30D106G015-BA2M8
C13	1	82	11077-820	Elmenco	DM15E820J
C30	1	1 μF, 50V, Elect.	11152-105	Whale	11-215BP1-50D65
C31	2	5 μF, 15V, Elect.	11151-505	Sprague	30D505G015-BA2M8
C32		Same as C31			
C50	6	0.001 μF, 100V, 10%, Mylar	11083-102	TRW	663UW10291
C51		Same as C50			
C52		Same as C50			
C53	1	470	11077-471	Sangamo	D155F471J03
C54		Same as C50			
C55	1	820	11077-821	Sangamo	D153F821J03
C76		Same as C4			
C77		Same as C50			

*Value is factory selected and may differ from the given value.

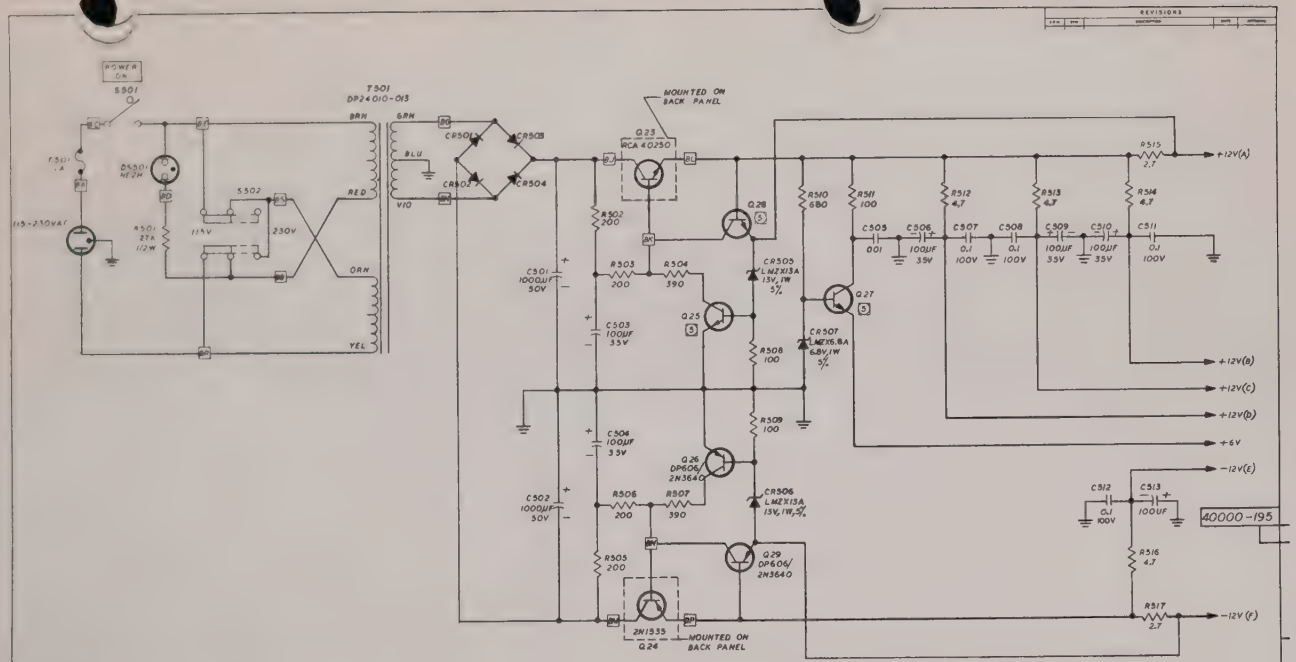
REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.2		Capacitors (continued)			
C110	3	0.05 μF, 25V, +80%, -20%, Cer.	11241-503	RMC	M-25
C111		Same as C4			
C112	2	10 μF, 35V, Ta.	11512-106	Sprague	150D106X903-5R2
C113	2	82, SM	11017-820	Sangamo	RR-1482
C130		Same as C110			
C131	1	Var., 7-25, 350V, Cer., Temp. Coef. N300	11305-250	Erie	538014-93B
C132		Same as C4			
C133		Same as C112			
C134		Same as C110			
C135	1	22	11077-220	Sangamo	D155E220J03
C136		Same as C113			
C501	2	1000 μF, 50V, Elect.	11162-108	Whale	BPC-1000-50
C502		Same as C501			
C503	6	100 μF, 35V, Elect.	11162-107	Whale	20-500BP100-35S85
C504		Same as C503			
C505		Same as C50			
C506		Same as C503			
C507		Same as C4			
C508		Same as C4			
C509		Same as C503			
C510		Same as C503			

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.2		Capacitors (continued)			
C511		Same as C4			
C512		Same as C4			
C513		Same as C503			
5.7.3		Transistors			
Q1	13	DP63-4, NPN	22635-004	FT	2N3646 or 2N3605
Q2		Same as Q1			
Q3		Same as Q1			
Q4		Same as Q1			
Q5		Same as Q1			
Q6		Same as Q1			
Q7	7	DP60-6, PNP	22605-006	FT	2N3640
Q8		Same as Q1			
Q9		Same as Q1			
Q10		Same as Q7			
Q11	4	DP63-3, NPN	22635-003	FT	2N2369A
Q12		Same as Q7			
Q13		Same as Q7			
Q14		Same as Q11			
Q15		Same as Q1			
Q16		Same as Q7			
Q17	1	DP60-5, PNP	22605-005	FT	FT1702
Q18		Same as Q1			

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
Q19		Same as Q11			
Q20		Same as Q11			
Q21	2	DP60-1, PNP	22605-001	Motorola	SM-4172
Q22		Same as Q21			
Q25		Same as Q1			
Q26		Same as Q7			
Q27		Same as Q1			
Q28		Same as Q1			
Q29		Same as Q7			
5.7.4	Diodes				
CR1	22	1N3600, Silicon	22164-000	FT	DP16-0
CR2	7	1N995, Ge.	12144-003	Sylvania	1N995
CR3		Same as CR1			
CR30		Same as CR1			
CR31		Same as CR1			
CR32		Same as CR1			
CR33		Same as CR1			
CR49		Same as CR1			
CR50	1	1N3717, Tunnel Diode, Ge.	12254-001	GE	1N3717
CR51		Same as CR1			
CR52		Same as CR1			
CR53		Same as CR1			
CR70		Same as CR1			
CR71		Same as CR2			

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.4		Diodes (continued)			
CR72		Same as CR1			
CR73		Same as CR1			
CR74		Same as CR1			
CR90		Same as CR1			
CR110		Same as CR1			
CR111		Same as CR2			
CR112		Same as CR1			
CR113		Same as CR1			
CR114		Same as CR1			
CR115		Same as CR2			
CR130		Same as CR2			
CR131		Same as CR2			
CR132		Same as CR1			
CR133		Same as CR1			
CR134		Same as CR1			
CR135		Same as CR2			
CR501	4	DP19-1, Silicon Rectifier	22194-001	DI	1N4002
CR502		Same as CR501			
CR503		Same as CR501			
CR504		Same as CR501			
CR505	2	Zener, 13V, 1W, 5%	12154-038	Semcor	Type M4Z
CR506		Same as CR505			
CR507	1	Zener, 6.8V, 1W, 5%	12154-037	Semcor	Type M4Z

REF. NO.	QTY. USED	DESCRIPTION	DATAPULSE PART NO.	MFR.	MFR. PART NO.
5.7.5	Inductors				
L70	1	Inductor, 1 μH, Phenolic core	14284-002	Wilco	205-11-10
5.7.6	Miscellaneous				
T70	1	Pulse Xfmr.	30000-019	DP	30000-019
	4	Ferrite Bead	19170-000	DP	19170-000



8 - DOTTED LINES AROUND TRANSISTORS INDICATE HEAT SINKS
7 - [BOXED] WORDING INDICATES FRONT PANEL NOMENCLATURE
6 - [BOXED] LETTERS INDICATE SPECIFIC LABELED POINTS ON CKT. BD.
5 INDICATES DP634/2N3603, 2N5646, MPS3646, MES021
4 - ALL DIODES ARE DP19-1/1N4002
3 - ALL CAPACITOR VALUES MORE THAN ONE ARE IN PF
2 - ALL CAPACITOR VALUES LESS THAN ONE, ARE IN µF
1 - ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%
NOTES: UNLESS OTHERWISE SPECIFIED

REFERENCE DESIGNATIONS		
T 501	T501	
DS 501	DS501	
F501	F501	
S501	S502	
Q23	Q29	
CR501	CR507	
C501	C513	
R501	R517	
FIRST USED	LAST USED	OMITTED

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

DRAWN	MARIAN M.	3/3/67	
CHECKED			
ENGINEER	H. Lentz	3/3/67	
APPROVED			
RELEASED	ECO 1183	3/3/67	

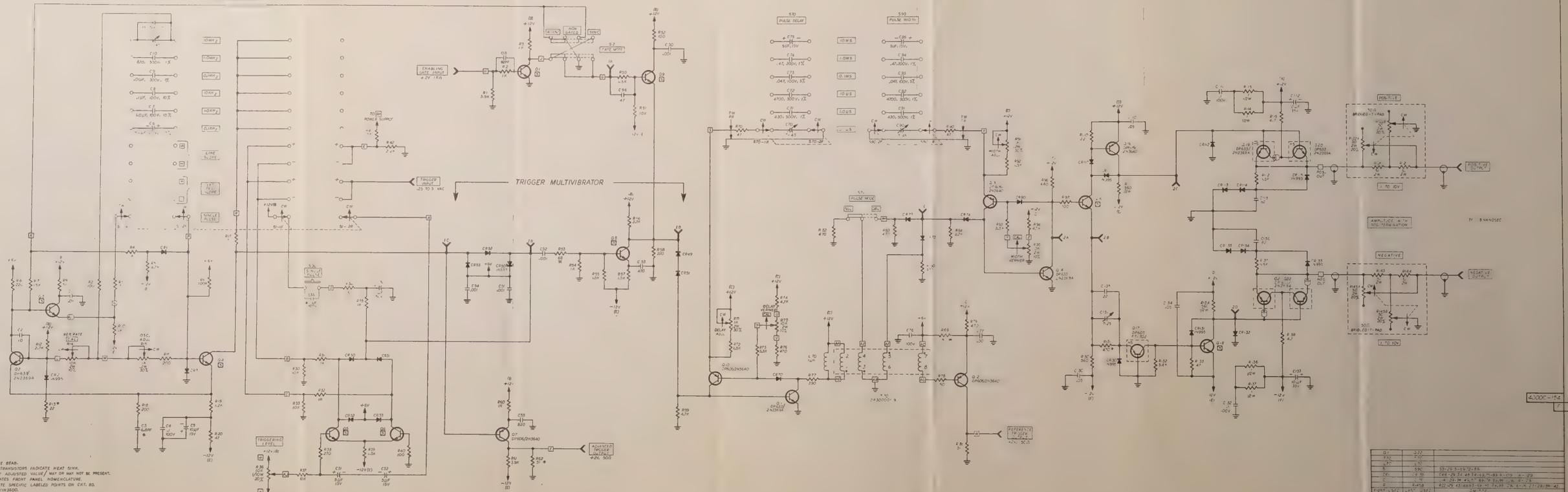
SCHEMATIC — POWER SUPPLY MODEL 101

DATAPULSE INC. HOLLYWOOD, CALIFORNIA

SIZE D | DWG NO. 40000-195 | SHEET 1 OF 1

NEXT ASSY | USED ON | NEXT ASSY | TRANS. ASSY | APPLICATION | QTY REQD

DO NOT SCALE DWG.



10- ⓕ INDICATES A FERRITE BEAD.
9- DOTTED LINES AROUND TRANSISTORS INDICATE HEAT SINK.
8- ⊕ INDICATES A FACTORY ADJUSTED VALUE / MAY OR MAY NOT BE PRESENT.
7- BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
6- BOXED LETTERS INDICATE SPECIFIC LABELED POINTS ON CRT. BD.
5- ALL DIODES ARE DP16-01 OR 1N3600.
4- Ⓣ INDICATES DP634/2N3605 OR 2N3646, MPS3646, MEM721.
3- ALL CAPACITOR VALUES GREATER THAN ONE ARE IN PF.
2- ALL CAPACITOR VALUES LESS THAN ONE ARE IN µF.
1- ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.
NOTES: UNLESS OTHERWISE SPECIFIED.

Q1	2323	
Q2	2N	
Q3	2N	
Q4	2N	
Q5	2N	
Q6	2N	
Q7	2N	
Q8	2N	
Q9	2N	
Q10	2N	
Q11	2N	
Q12	2N	
Q13	2N	
Q14	2N	
Q15	2N	
Q16	2N	
Q17	2N	
Q18	2N	
Q19	2N	
Q20	2N	
Q21	2N	
Q22	2N	
Q23	2N	
Q24	2N	
Q25	2N	
Q26	2N	
Q27	2N	
Q28	2N	
Q29	2N	
Q30	2N	
Q31	2N	
Q32	2N	
Q33	2N	
Q34	2N	
Q35	2N	
Q36	2N	
Q37	2N	
Q38	2N	
Q39	2N	
Q40	2N	
Q41	2N	
Q42	2N	
Q43	2N	
Q44	2N	
Q45	2N	
Q46	2N	
Q47	2N	
Q48	2N	
Q49	2N	
Q50	2N	
Q51	2N	
Q52	2N	
Q53	2N	
Q54	2N	
Q55	2N	
Q56	2N	
Q57	2N	
Q58	2N	
Q59	2N	
Q60	2N	
Q61	2N	
Q62	2N	
Q63	2N	
Q64	2N	
Q65	2N	
Q66	2N	
Q67	2N	
Q68	2N	
Q69	2N	
Q70	2N	
Q71	2N	
Q72	2N	
Q73	2N	
Q74	2N	
Q75	2N	
Q76	2N	
Q77	2N	
Q78	2N	
Q79	2N	
Q80	2N	
Q81	2N	
Q82	2N	
Q83	2N	
Q84	2N	
Q85	2N	
Q86	2N	
Q87	2N	
Q88	2N	
Q89	2N	
Q90	2N	
Q91	2N	
Q92	2N	
Q93	2N	
Q94	2N	
Q95	2N	
Q96	2N	
Q97	2N	
Q98	2N	
Q99	2N	
Q100	2N	

REFERENCE DESIGNATIONS

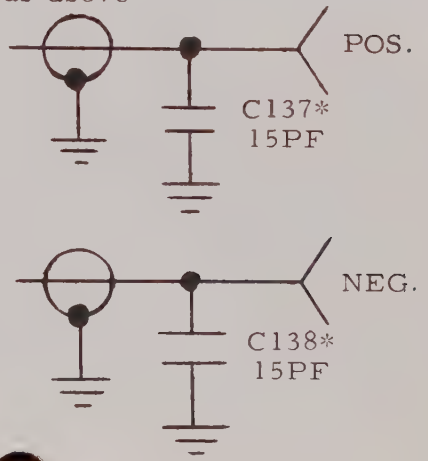
SCHEMATIC - MODEL 101

4000-154

ADDENDA AND ERRATA

E. O. NO.	EFFECTIVE DATE	DWG. NO.	CHANGE
2402	1-16-68	40000-154 L/M37000-429	M-101 Pulse Generator 1. Add ferrite bead P/N 19170-000 on wire at point G on board. 2. Add asterisk after bead. Assy. - Main Board 3. Same as above.
2400	S/N01258 & subsequent	Tunnel diode substitution	Where GE IN3717, DP-P/N 12254-001 is used, substitute GE TD717, DP-P/N 12254-003. NOTE: The TD717 is packaged backwards.
None	2-20-68	None	To correct typographical error in manual: The first word of the second paragraph of 2.4.4 Nonlinear Loads should read Values.

2422	S/N 01248	J40000-154 F D40000-195 NC	1. Install a ferrite bead P/N 19170 on the base of Q19 & Q27. 2. Add an asterisk (*) to the base and collector (already in) of Q19, the base of Q21 (already in) and the base of Q27.
		L/M37000-429	Same as above.
2424	S/N 01248	J40000-154 F	1. Install a 15PF DIP Mica Capacitor P/N 11077-150 at the outputs BNC to Grd.
		L/M37000-424	2. Same as above



ADDENDA AND ERRATA

E. O. NO.	EFFECTIVE DATE	DWG. NO.	CHANGE
2431	3-19-68	40000-154 F	Schematic 1. Change R55 from 1.5K, 1/4W, 5% to 1.8K, 1/4W, 5%, P/N 10010-182. 2. Change R56 from 2.7K, 1/4W, 5% to 3.9K, 1/4W, 5%, P/N 10010-392. 3. Change R80, 82 & 83 from 470Ω, 1/4W, 5% to 680Ω, 1/4W, 5%, P/N 10010-681.
		LM37000-429	Assy. - Main Bd. 4. Same as above.
Errata	4-1-68	Manual	Page 5-10, add: R69* 51Ω, 1/4W, 5% Part Number: 10010-510
2434	Serial No. 01288 & subs.	LM37000-429	Parts List, Main Circuit Board: 1. Change R69 from 51Ω 1/4W 5%, P/N 10010-510 to 27Ω 1/4W 5%, P/N 10010-270. On stuffing print R69 is still factory adjust.

SEMICONDUCTOR REPLACEMENTS

(Applicable to all Datapulse Models except the 102.)

Datapulse makes extensive use of house labeled semiconductors, superseding or used in place of commercial equivalents. In most cases, these are procured against relaxed or actual commercial equivalent specifications, and commercial equivalents as listed below may, therefore, be used as replacements.

DATAPULSE TYPE NO.	DATAPULSE PART NO.	COMMERCIAL EQUIVALENT
Diodes:		
DP16-0	22164-000	1N3600
DP16-1	22164-001	1N3604
DP16-2	22164-002	HPA1003
DP19-0	22194-000	1N2070
DP19-1	22194-001	1N4002
DP19-6	22194-006	1N2071
Transistors:		
DP43-0	22435-000	2N984
DP46-0	22465-000	2N964A
DP46-1	22465-001	None*
DP59-0	22595-000	2N1132A
DP60-0	22605-000	2N2411
DP60-1	22605-001	None*
DP60-2	22605-002	2N2904 or 2N3133
DP60-3	22605-003	2N2894
DP60-4	22605-004	2N3209
DP60-5	22605-005	FT1702
DP60-6	22605-006	2N3640
DP60-7	12605-007	None*
DP63-0	22635-000	2N2369 or 2N2501
DP63-1	22635-001	2N3723
DP63-2	22635-002	None*
DP63-3	22635-003	2N2369A (Fairchild)
DP63-4	22635-004	2N3646 or MPS3646 or 2N2369A
DP63-6	22635-006	2N2270

*Replacements for the following items should be procured from Datapulse:

DP46-1 is selected from 2N2964A for high Beta.
DP60-1 is selected from 2N2894 for high V ceo.
DP63-2 is selected from 2N914 for tighter Beta tolerance.
DP60-7 is selected from DP60-1 for 25 volt breakdown.

12/8/67

DATAPULSE

Product Summary

Pulse Generators

	MODEL	REP. RATE	DELAY	DURATION	RISE & FALL TIMES	OUTPUT	PRICE
	101*	10Hz – 10MHz sgl. or dbl. pulse	40ns to 10ms	35ns to 10ms	Typically <5ns rise <7ns fall (Max. 10ns)	Simultaneous ±10V into 50Ω	$395.00
	102	2Hz – 3MHz	0.2μs–10ms	50ns–10ms	variable 10-500ns	±50V into 50Ω	$720.00
	102-S1A	Like 102 but offers variety of multipulse formats.					$1650.00
	102-S3	Like 102 except also provides two pulses per cycle at rep rates to 800KHz, with separation variable from 0.5μs to 10ms.					$920.00
	102-S4	Like 102 except provides up to 10ms delay or advance of main pulse and five-turn control resolution on delay.					$920.00
	103M*	<5Hz – 5MHz	0.1μs–5ms, two channels provided	Outputs are provided by plug-in output units (see below) — 1 req'd. for single pulse, 2 for double pulse.			$880.00
	106A*	10Hz – 12MHz sgl. or dbl. pulse	<40ns–5ms	<25ns–5ms	separately variable 10ns–1ms	Simultaneous ±12V into 50Ω	$950.00
	108*	10Hz – 10MHz	0–5ms	<25ns–5ms	Variable 7–50ns	±50V into 50Ω	$1480.00
	108L*	10Hz – 10MHz	0–5ms	<30ns–5ms	Separately variable linear rise 12ns–12.5μs	±50V into 50Ω	$1980.00
	109*	4Hz – 40MHz sgl. or dbl. pulse	10ns advance to 50ms delay	10ns–50ms	<5 ns	Simultaneous ±10V into 50Ω	$690.00
	110A*	4Hz – 40MHz sgl. or dbl. pulse	10ns advance to 50ms delay	10ns–5ms	Separately variable linear 4ns–500μs	Simultaneous ±10V into 50Ω DC offset to 10V	$1250.00
	111*	4Hz – 40MHz sgl. or dbl. pulse	15ns advance to 50ms delay	8ns to 0.5ms	Separately variable linear 2ns to 500ns rise, 3ns to 500ns fall	±5V into 50Ω, DC offset to 5 volts	$1480.00
Programmable	110FP*	Like 110A except allows remote control and/or automatic programming of all pulse parameters except amplitude.					$2530.00
Programmable	110FP-A2*	Provides manual control of programmed functions or allows programming from parallel logic lines of all parameters, including amplitude.					$3590.00
Programmable	G2*	Incorporated in 110FP-A2, also available separately, for control of pulse amplitudes. Allows attenuation to be varied from 0–39.9 dB in 0.1 dB steps.					$920.00

Digital Data Generators

MODEL	CLOCK RATE	SERIAL BITS/WD	NO. OF CHANNELS (BITS/CHARACTER)	OUTPUT	OTHER FEATURES	PRICE
200M	2Hz–2MHz	1–100 or 1–50	1 or 2	Outputs are provided by plug-in output units (see below) 1 req'd. for 1 channel, 2 req'd. for 2 channel use.	Selectable sync bit. Single word command	$3710.00
202M	5Hz–5MHz	16	1 or 2		Each channel may be delayed 0.1μs–5ms from clock.	$1720.00
202M-S1	Like Model 202M except also providing single word command capability and last bit sync output.					$2200.00
201	to 10MHz	16	1	Simultaneous and complementary NRZ outputs to 10V, variable baseline offset to ±10V.	Provides RZ formats when triggered from async-gated pulse generator.	$680.00
203	10Hz to 20MHz	1–100 or 1–50	1 or 2	±5V into 50 ohms variable duration 10ns to 5ms or NRZ	Variable delay 0–50ms for NRZ or variable width, bit and word repeat modes, word command & frame command, PCM mode.	$5700.00
206	2Hz–2MHz	16 fixed plus bits or pair repeats	6	±12V from 100Ω programmed triggers	Selected sync. from any combination of intervals	$3590.00
206M	2Hz–2MHz	1–100	6	±6V from 100 ohms	Independent delay, width, and amplitude	$7170.00
208	5Hz–5MHz	1 to 16 plus variable repeats	8	6V into 50 ohms • RZ or NRZC Variable width optional	Manual or triggered single frame	$6680.00
208-S1	Same as 208, except provides simultaneous positive and negative outputs and pulse duration control from 0.5μs to 5ms.					$7460.00
215C	1Hz–1MHz	Independently selectable word lengths for sync. and data words 1–32 bits.	1 PCM channel, 3 independent word types: sync, common and special frames to 512 words.	True and complement variable amplitude and lower level from 1 to 12 volts from 50 ohms, RZ, NRZ and bi-phase.	Provides for data perturbation and a reference data output (fixed output level 12 volts from 50 ohms). Common data word may be externally programmed. Special data word may be inserted in any word position except the first.	$4750.00

Plug-in Output Units

TYPE	DURATION	RISE TIME	OUTPUT	OTHER FEATURES	PRICE
P901	50ns–2ms or NRZ**	Variable <20—> 300ns	Simultaneous ±15V into 50Ω	Current source, separate controls for ±outputs. Outputs may be mixed.	$570.00
P902	2μs–50ms or NRZ**	Approx. 0.1μs	Upper level 1 to 15V lower level —1 to —15V, from 600Ω	On-off modulates external carriers (to 20kc) providing up to 16V p–p, from 600Ω	$470.00
P903	50ns–2ms or NRZ**	<5 ns	Simultaneous ±5V into 50Ω	Outputs may be mixed	$270.00
P904	<0.2μs	<50 ns	±15V or ±5V into 50Ω	Two channels provided, i.e., only 1 unit req'd. for two channel instrument	$185.00
P905	50ns–500μs	Variable <20ns–1μs	±25V into 50Ω	5% waveform aberrations	$610.00
P906	2ns–200ns	<1ns	±10V into 50Ω	Two units with Model 103M provide double pulse operation	$980.00

*INDICATES SOLID-STATE INSTRUMENT **NRZ OUTPUT IS PROVIDED ONLY WHEN USED WITH MODELS 200M, 202M, OR 202M-S1

Datapulse Incorporated — A Subsidiary of Systron Donner Corporation, 10150 West Jefferson Blvd., Culver City, California 90230.
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WARRANTY

Datapulse Incorporated warrants each instrument of its manufacture to be free from defects in material and workmanship. Our obligation under this Warranty is limited to servicing or adjusting any instrument returned to our factory for that purpose, and to making good at our factory any part or parts thereof except tubes, transistors, fuses or batteries which shall, within one year after making delivery to the original purchaser, be returned to us with transportation charges prepaid, and which our examination shall disclose to our satisfaction to have been thus defective.

Instruments returned under this Warranty will not be accepted at the Datapulse plant without prior authorization by a Datapulse representative or by the service manager of Datapulse Incorporated.

Datapulse Incorporated reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This Warranty is expressly in lieu of all other obligations or liabilities on the part of Datapulse Incorporated and Datapulse Incorporated neither assumes nor authorizes any other person to assume for them any other liability in connection with the sales of Datapulse Incorporated instruments.

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